Measurement of Jet Inclusive Cross Section using the KT Algorithm in CDF RUN2

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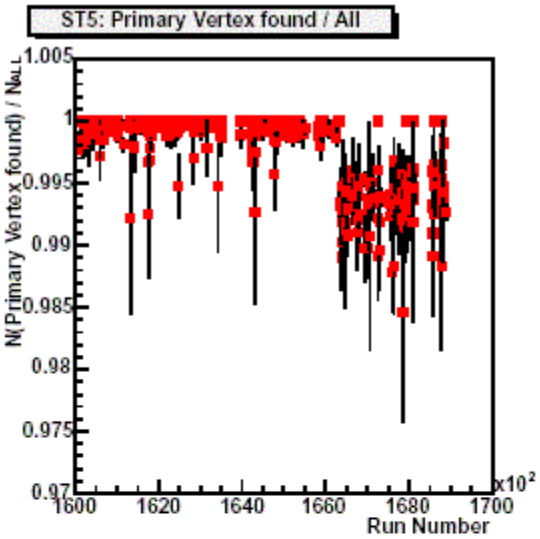
IFAE

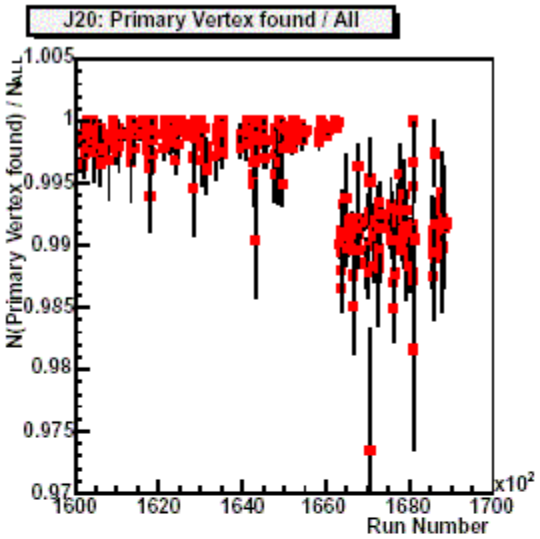
Introduction

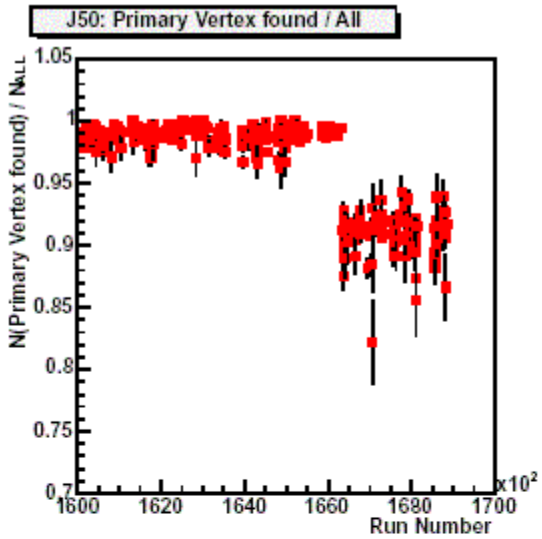
- Context
  - $0.1 < |Y| < 0.7$
  - D = 0.5, 0.7 and 1.0
- Plan
  - Used data
  - Cuts
  - Trigger study
  - P_T corrections
  - Unfolding
  - Systematics
  - Results

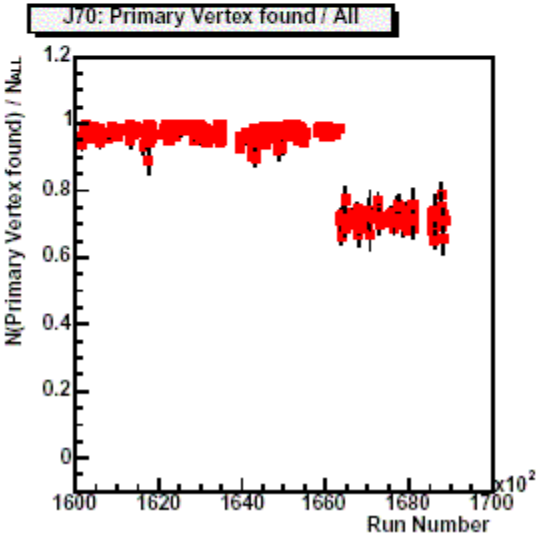
Used data

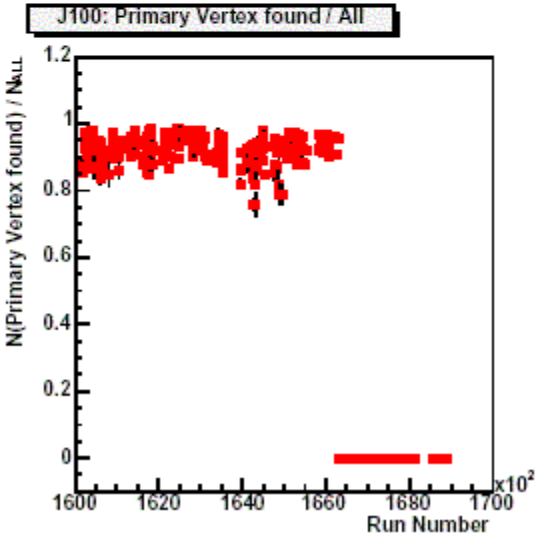
- Datasets xxxx0c
  - ST5, J20, J50, J70 and J100 Triggers
- Runs used
  - V4 of QCD good run list
  - Excluded runs
    - Processing problem (why?)
      - [154594, 155895] and [156099, 160151]
    - Vz proble in production software
      - ≥166328: loose around $35pb^{-1}$
    - Only for ST5: unconstant L2 prescale
      - < 147870
- Integrated luminosity: $145pb^{-1}$ ($129pb^{-1}$ for ST5)


ST5: Primary Vertex found / All
N(Primary Vertex found) / NALL
1.005
1
0.995
0.99
0.985
0.98
0.975
0.97
1600
1620
1640
1660
1680
1700
x10²
Run Number


J20: Primary Vertex found / All
N(Primary Vertex found) / NALL
1.005
1
0.995
0.99
0.985
0.98
0.975
0.97
1600
1620
1640
1660
1680
1700
x10²
Run Number


J50: Primary Vertex found / All
N(Primary Vertex found) / NALL
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
1600
1620
1640
1660
1680
1700
x10²
Run Number

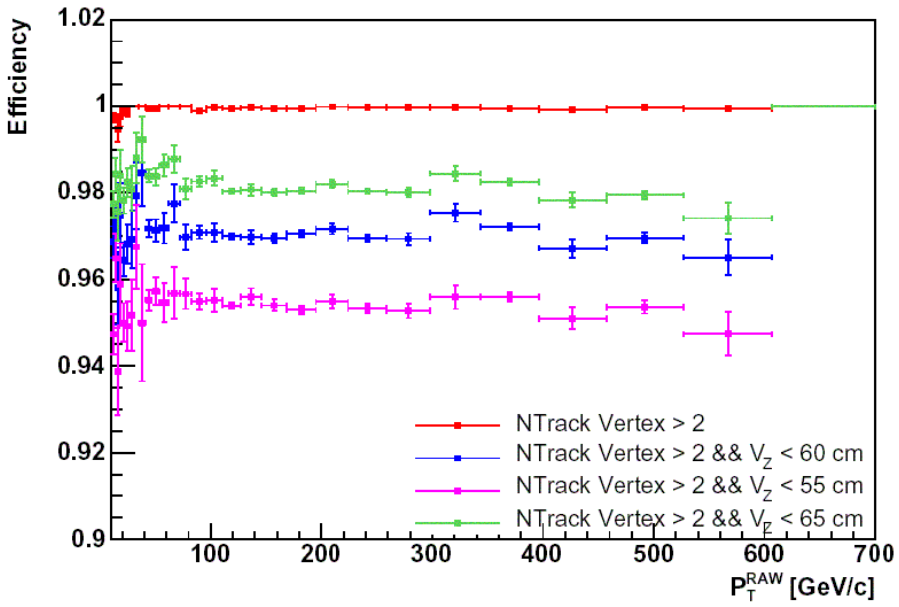

J70: Primary Vertex found / All
N(Primary Vertex found) / NALL
1.2
1
0.8
0.6
0.4
0.2
0
1600
1620
1640
1660
1680
1700
x10²
Run Number


J100: Primary Vertex found / All
N(Primary Vertex found) / NALL
1.2
1
0.8
0.6
0.4
0.2
0
1600
1620
1640
1660
1680
1700
x10²
Run Number

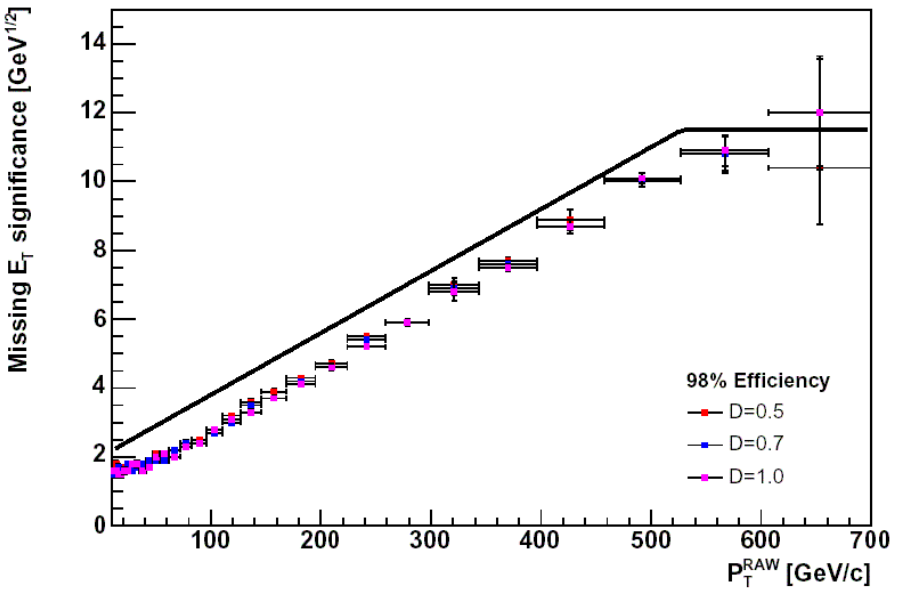
Cuts

- $0.1 < |Y| < 0.7$
- $|Vz| < 60cm$
  - With at least 3 associated tracks
- Missing E_T significance
  - Cut function of P_T

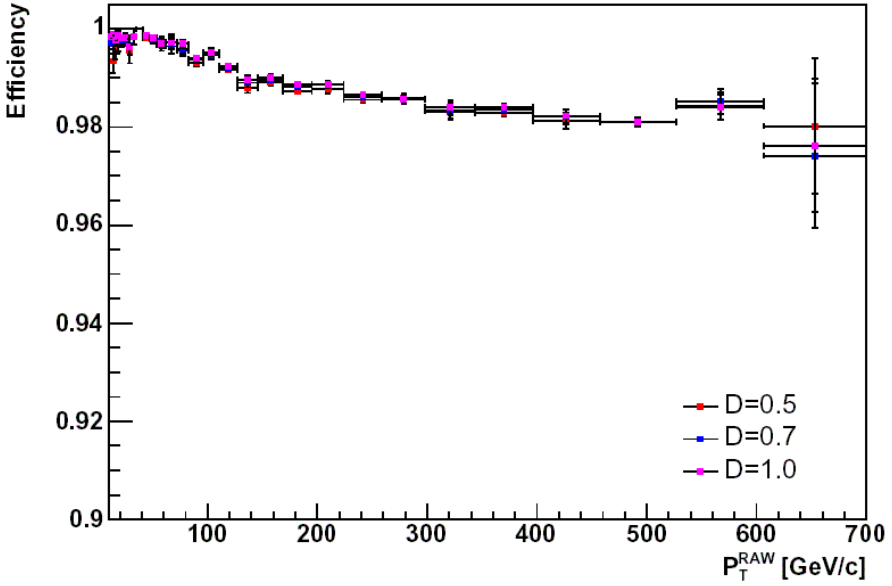
D=0.5 PYTHIA: vertex cut efficiencies



PYTHIA: missing E_T significance cut study



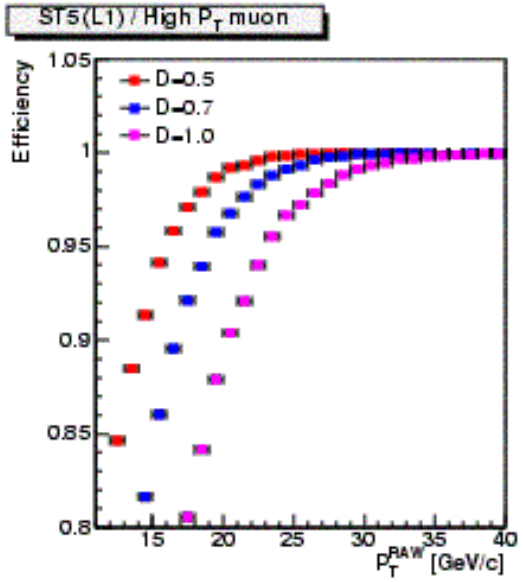
PYTHIA: missing E_T significance cut efficiency

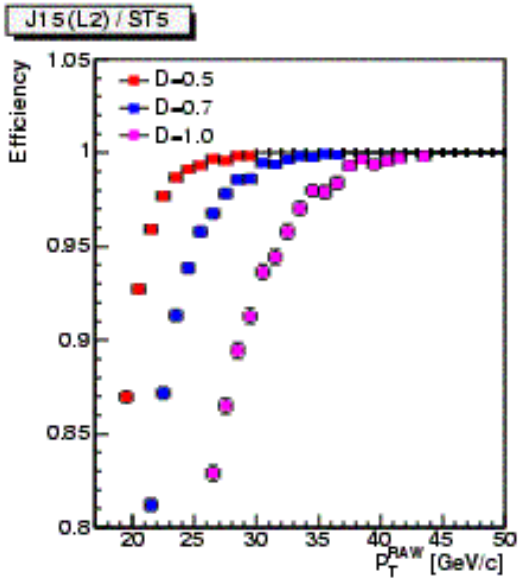


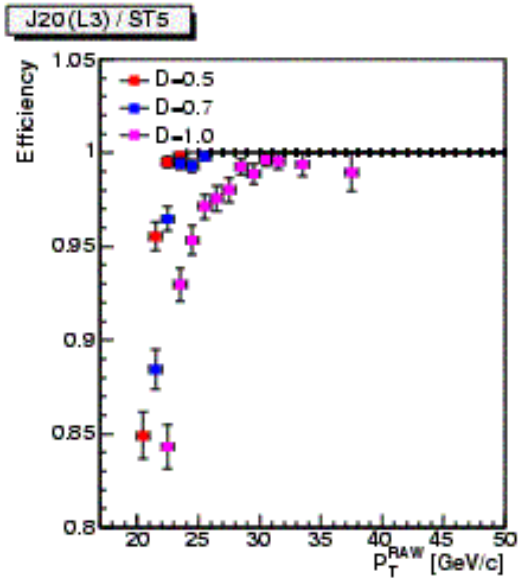
Trigger study

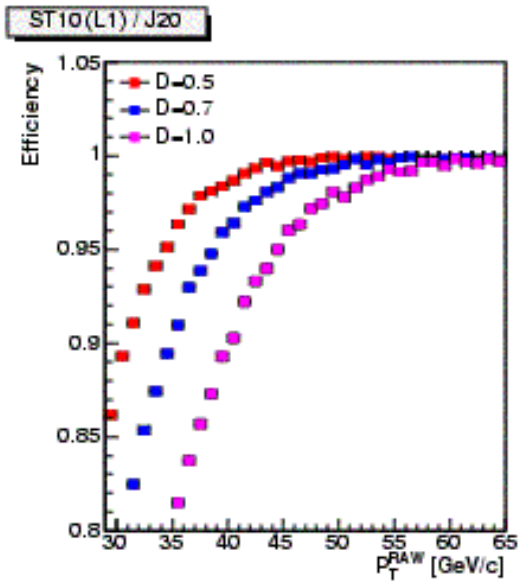
- Study done for L1, L2 and L3
  - Use high PT muon trigger to get ST5 efficiency
- Minimal raw P_T used

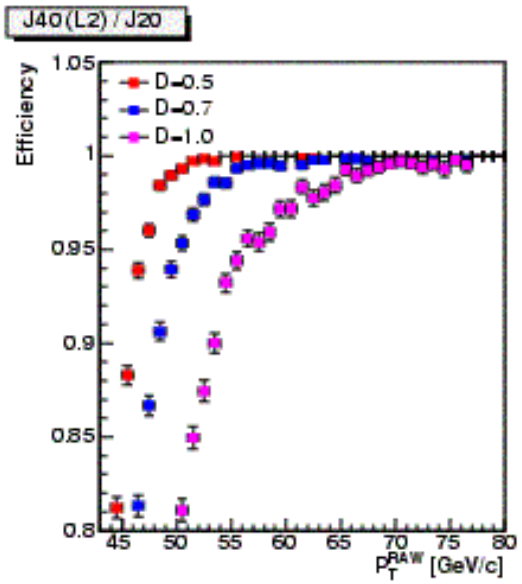
Trigger	D = 0.5 / 0.7 / 1.0
ST5	23 / 27 / 31
J20	27 / 35 / 41
J50	62 / 62 / 72
J70	83 / 96 / 96
J100	127 / 127 / 146

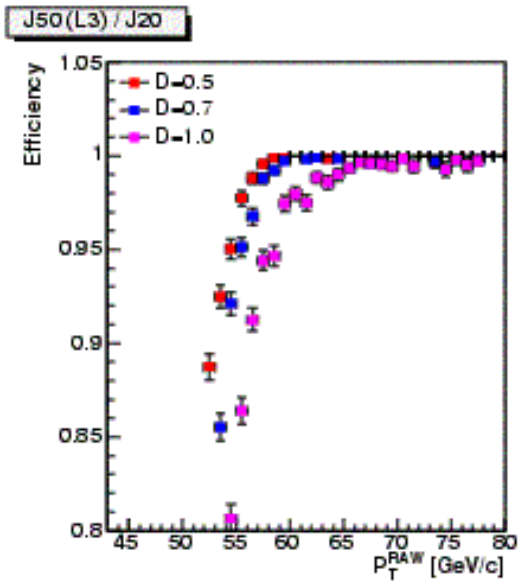

ST5(L1) / High P_T muon
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]

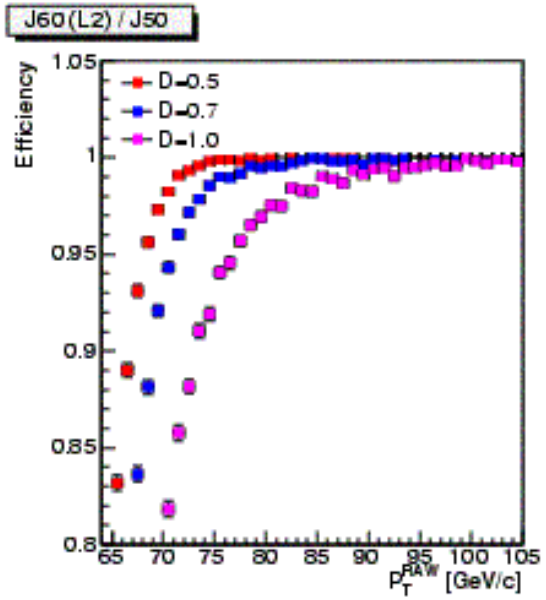

J15(L2) / ST5
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]

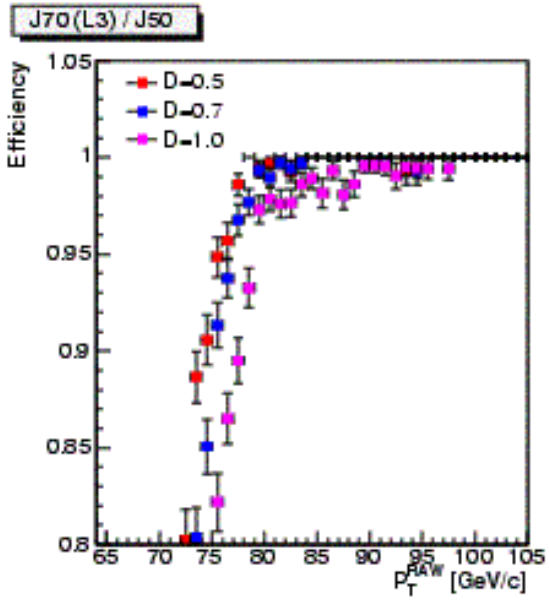

J20(L3) / ST5
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]

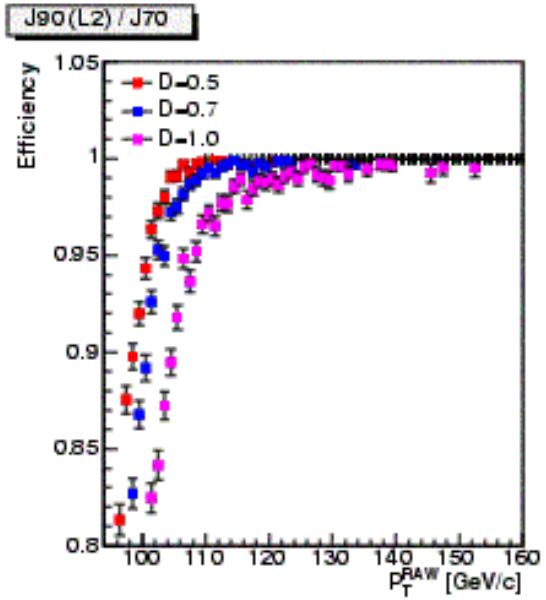

ST10(L1) / J20
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]

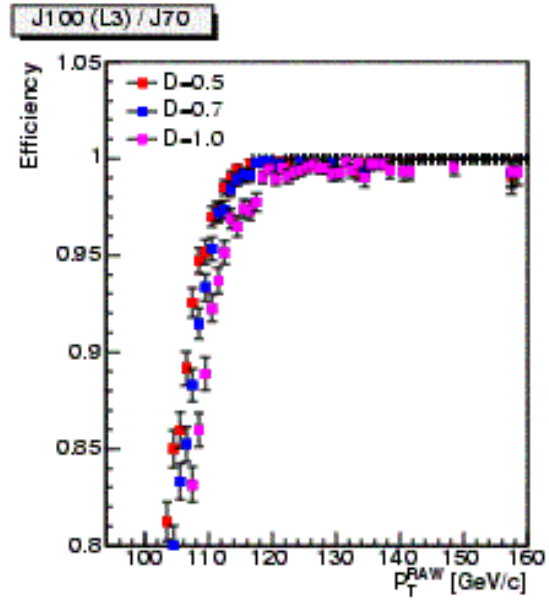

J40(L2) / J20
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]

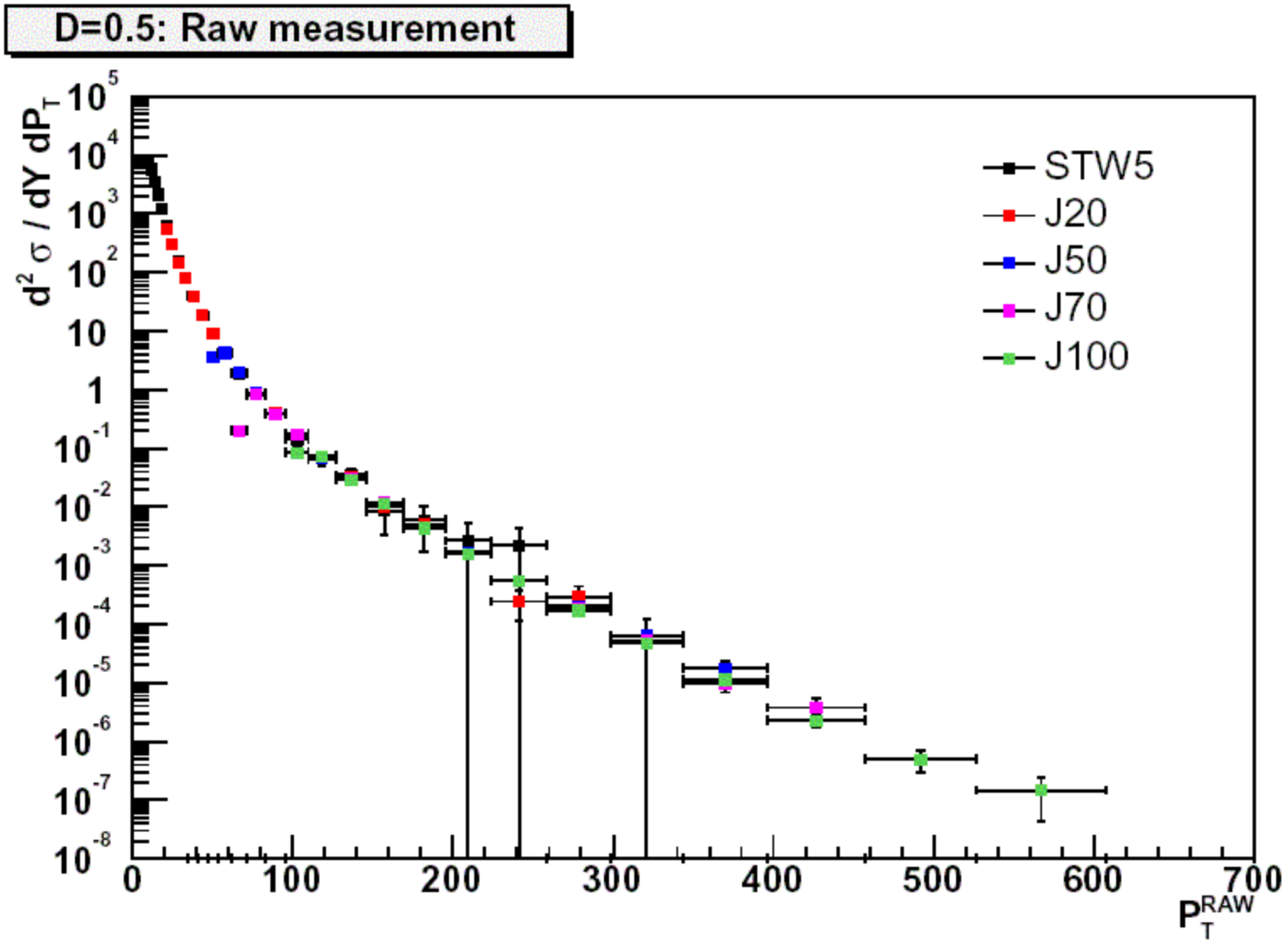

J50(L3) / J20
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]

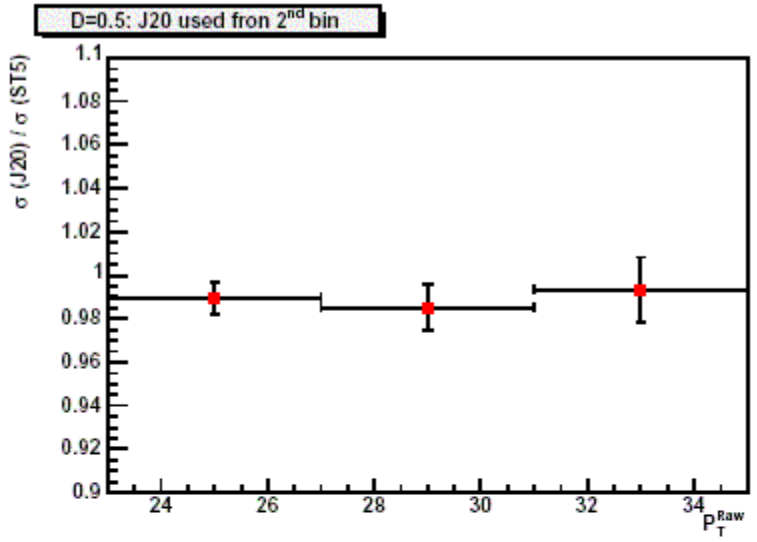

J60(L2) / J50
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]

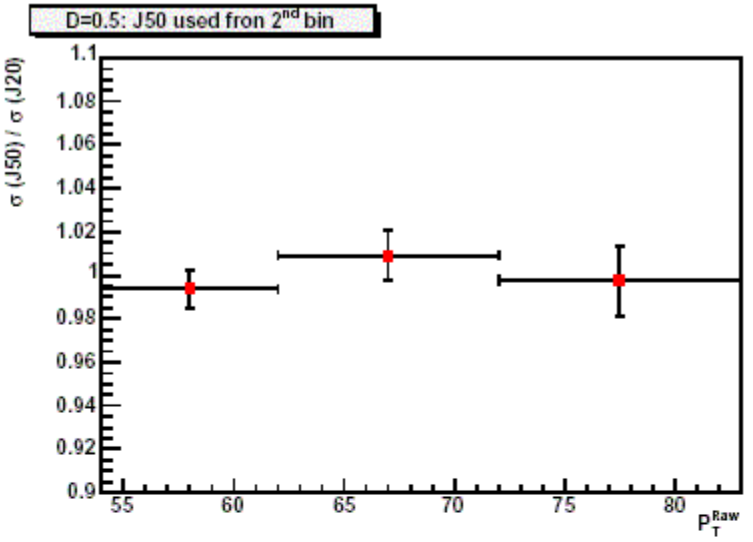

J70(L3) / J50
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]

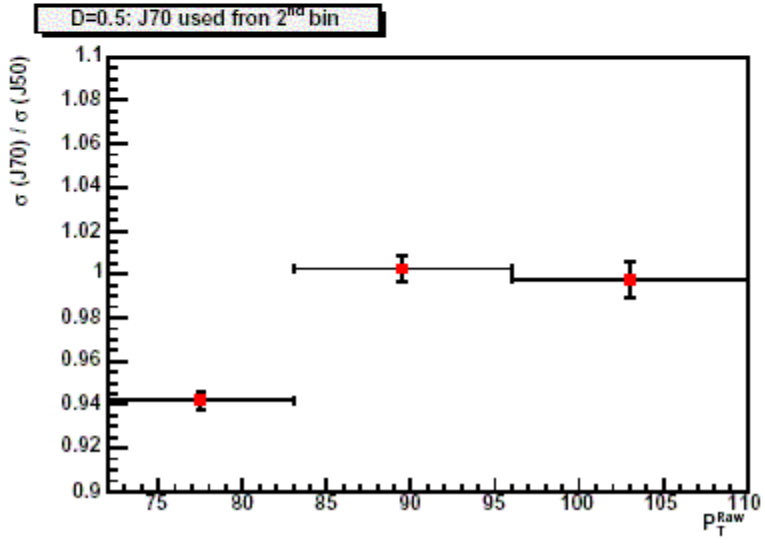

J90(L2) / J70
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]

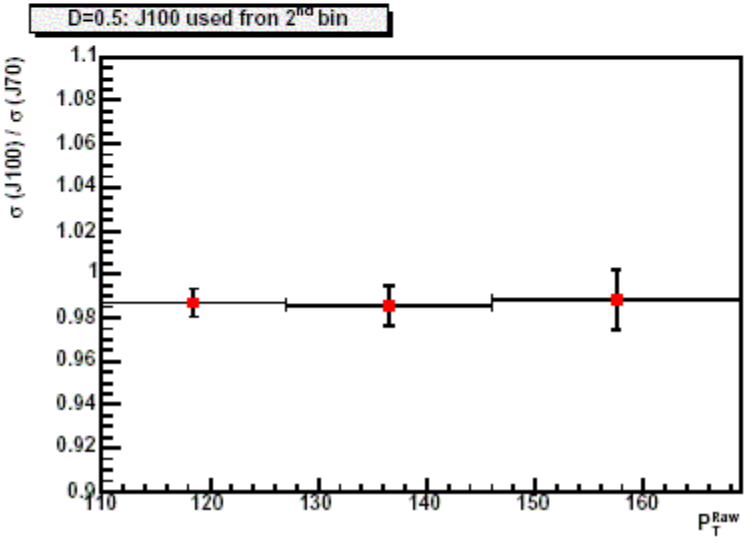

J100(L3) / J70
Efficiency
D=0.5
D=0.7
D=1.0
P_T^{RAW} [GeV/c]


D=0.5: Raw measurement
$d^2\sigma / dY\, dP_T$
10^5
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
0
100
200
300
400
500
600
700
P_T^{RAW}
STW5
J20
J50
J70
J100


D=0.5: J20 used fron 2nd bin
σ (J20) / σ (ST5)
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
24
26
28
30
32
34
P_T^Raw

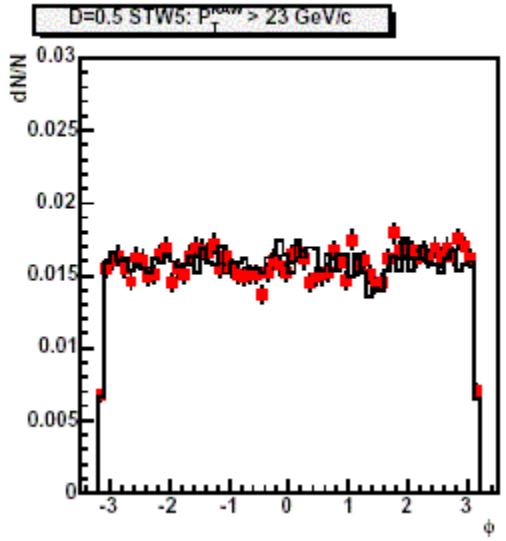

D=0.5: J50 used fron 2nd bin
σ (J50) / σ (J20)
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
55
60
65
70
75
80
P_T^Raw

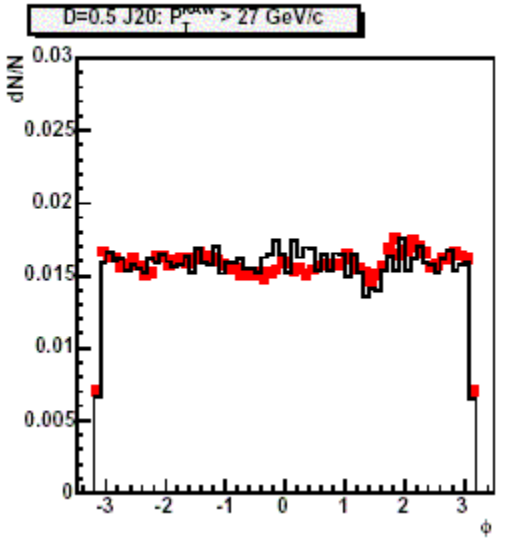

D=0.5: J70 used fron 2nd bin
σ (J70) / σ (J50)
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
75
80
85
90
95
100
105
110
P_T^Raw

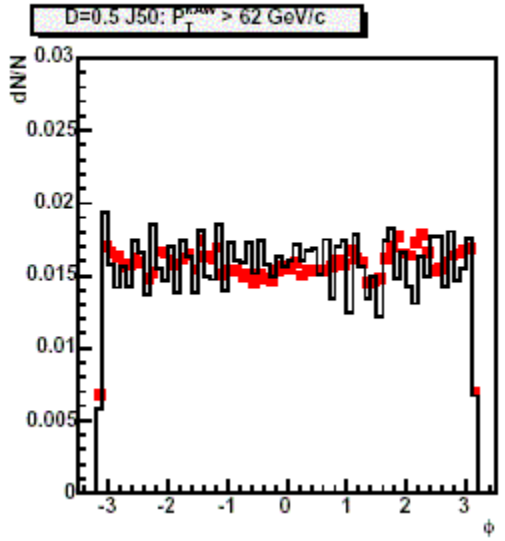

D=0.5: J100 used fron 2nd bin
σ (J100) / σ (J70)
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
110
120
130
140
150
160
P_T^Raw

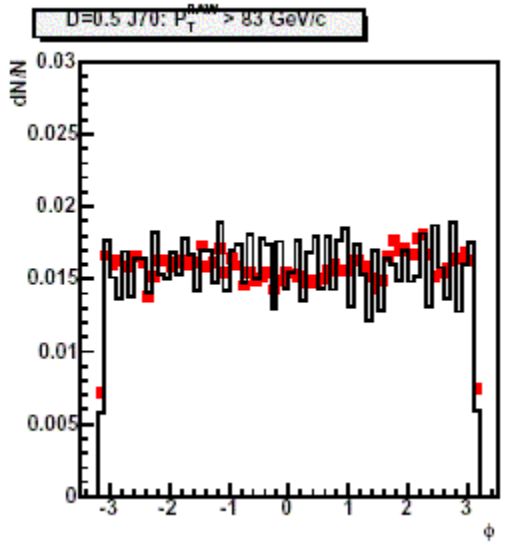
P_T corrections

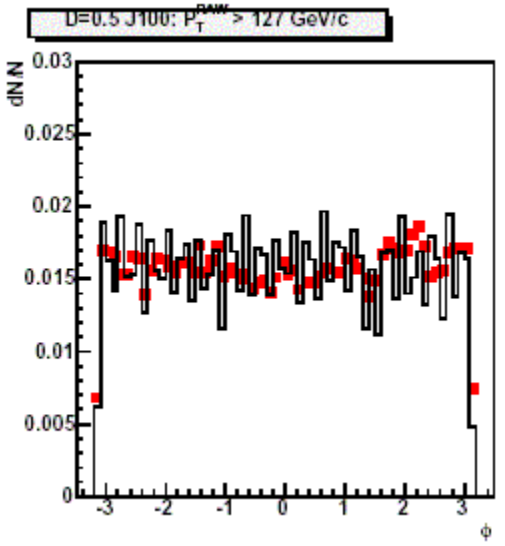
- From PYTHIA:
  - Matching Calorimeter/Hadron Jets
    - $\Delta R < D$ in ϕ–Y plan
  - $< P_T$ Raw – P_T Had $>$ vs $< P_T$ Raw $>$
- Pile-up correction
  - - $\Psi\times$ Number of additionnal primary vertices
  - Ψ values extract from dedicated studies performed with cone algorithm
    - 100% systematics uncertainty
    - 0.400, 0.781 and 1.581GeV/c respectively for D = 0.5, 0.7 and 1.0

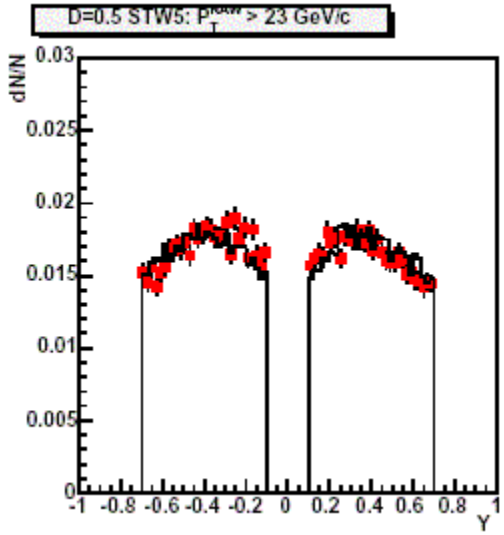

D=0.5 STW5: P_T^{RAW} > 23 GeV/c
dN/N
0.03
0.025
0.02
0.015
0.01
0.005
0
-3
-2
-1
0
1
2
3
φ

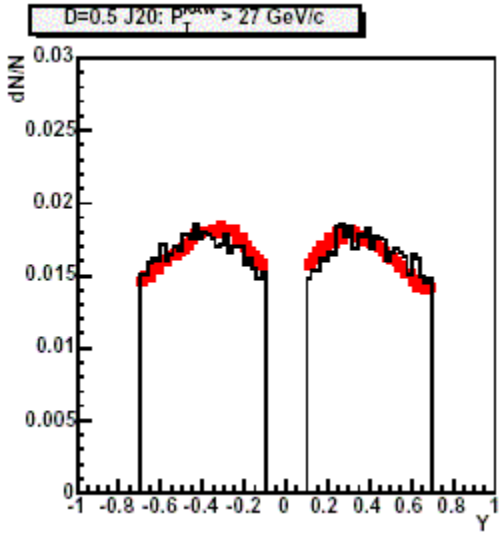

D=0.5 J20: P_T^{RAW} > 27 GeV/c
dN/N
0.03
0.025
0.02
0.015
0.01
0.005
0
-3
-2
-1
0
1
2
3
φ

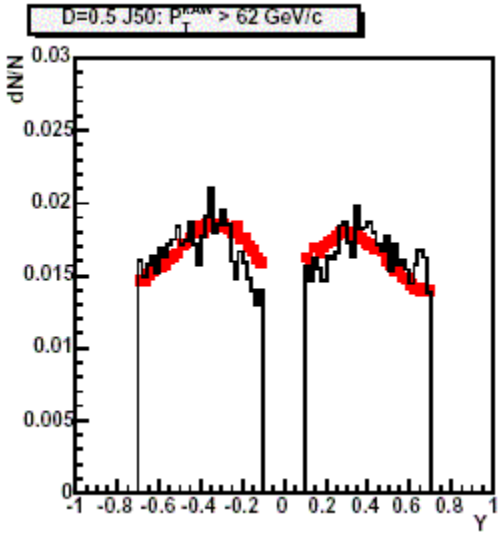

D=0.5 J50: P_T^{RAW} > 62 GeV/c
dN/N
0.03
0.025
0.02
0.015
0.01
0.005
0
-3
-2
-1
0
1
2
3
φ

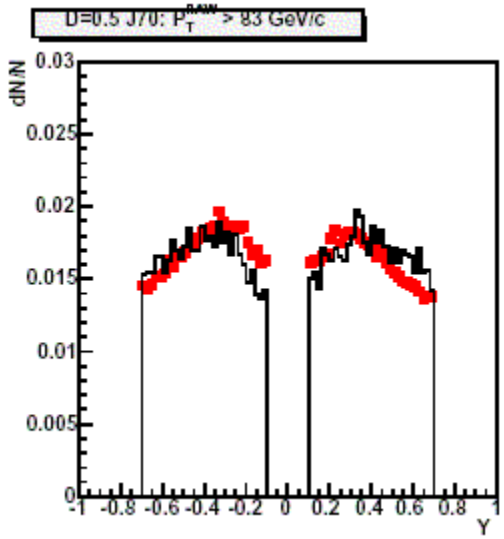

D=0.5 J70: P_T^{RAW} > 83 GeV/c
dN/N
0.03
0.025
0.02
0.015
0.01
0.005
0
-3
-2
-1
0
1
2
3
φ

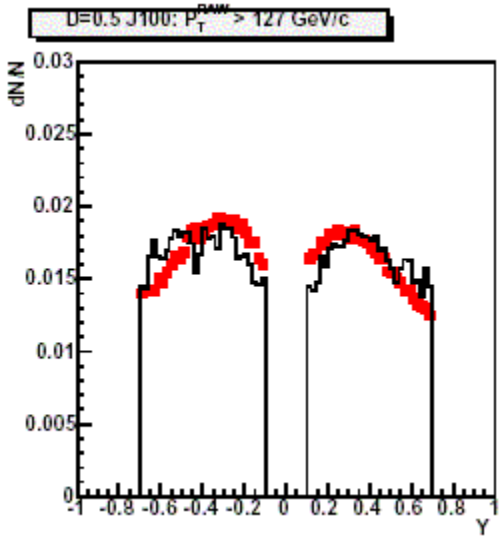

D=0.5 J100: P_T^{RAW} > 127 GeV/c
dN/N
0.03
0.025
0.02
0.015
0.01
0.005
0
-3
-2
-1
0
1
2
3
φ

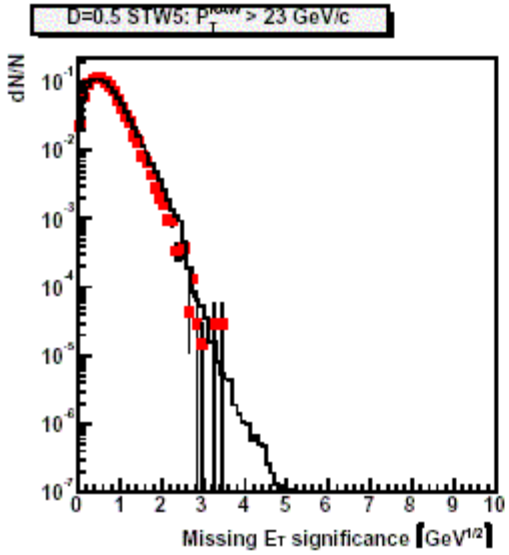

D=0.5 STW5: P_T^{RAW} > 23 GeV/c
dN/N
Y

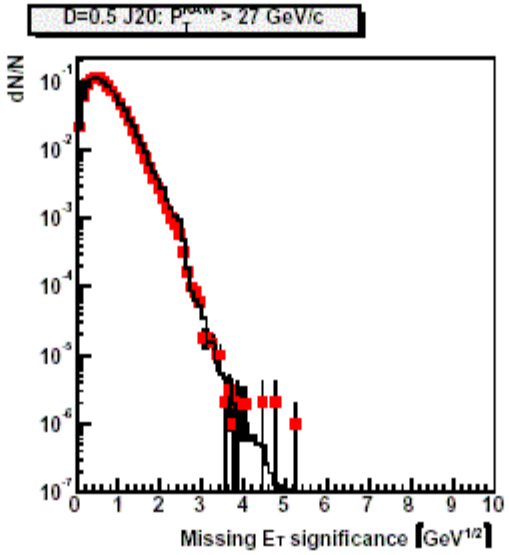

D=0.5 J20: P_T^{RAW} > 27 GeV/c
dN/N
Y

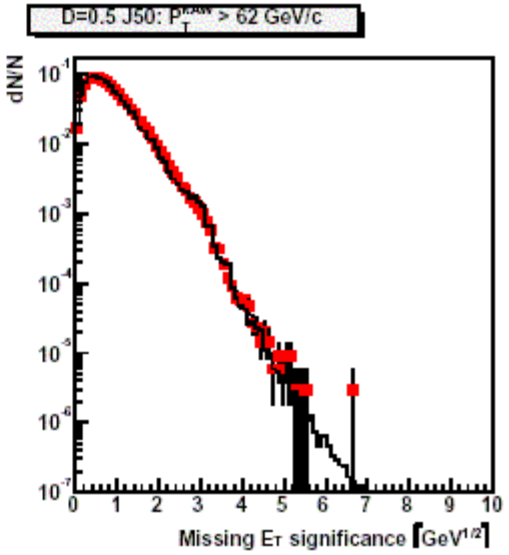

D=0.5 J50: P_T^{RAW} > 62 GeV/c
dN/N
Y

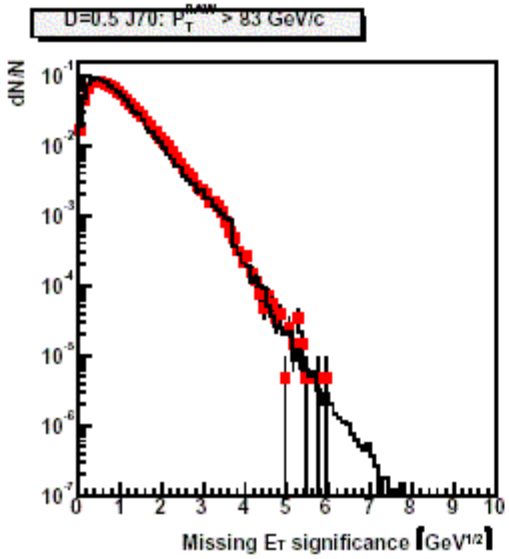

D=0.5 J70: P_T^{RAW} > 83 GeV/c
dN/N
Y

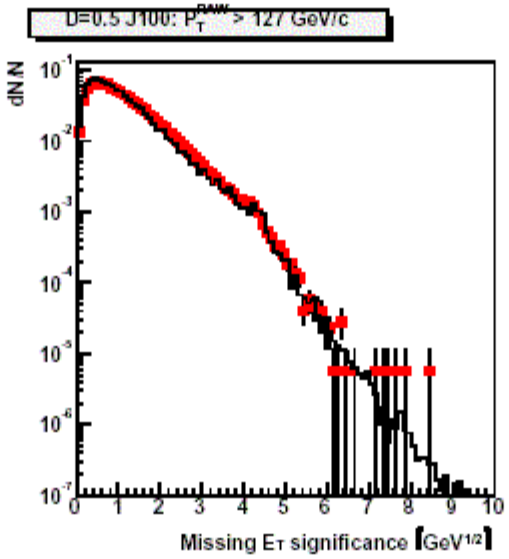

D=0.5 J100: P_T^{RAW} > 127 GeV/c
dN/N
Y

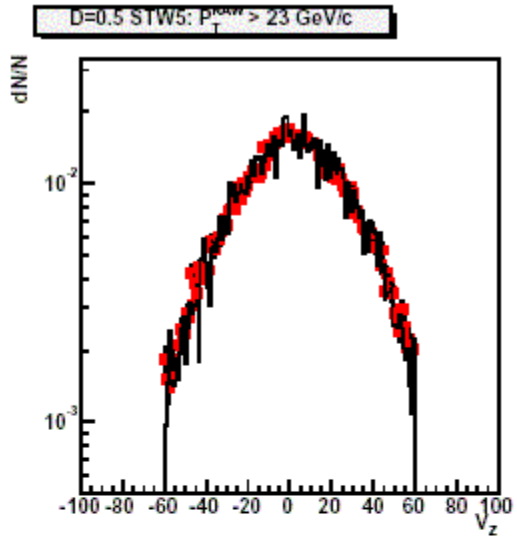

D=0.5 STW5: P_T^{RAW} > 23 GeV/c
dN/N
Missing E_T significance [GeV$^{1/2}$]

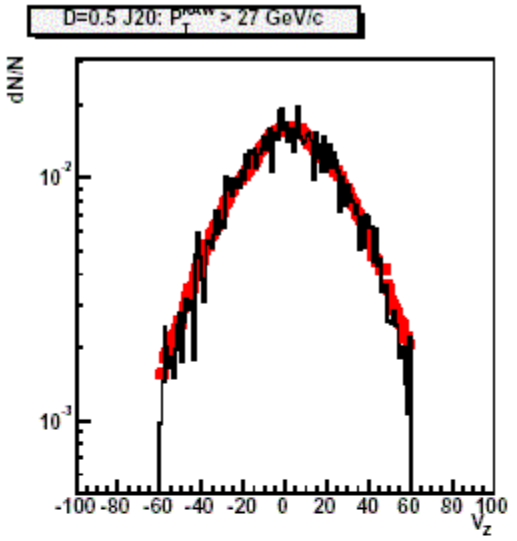

D=0.5 J20: P_T^{RAW} > 27 GeV/c
dN/N
Missing E_T significance [GeV$^{1/2}$]

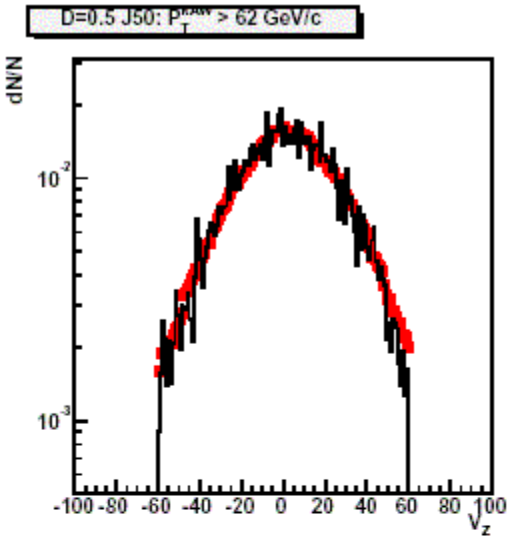

D=0.5 J50: P_T^{RAW} > 62 GeV/c
dN/N
Missing E_T significance [GeV$^{1/2}$]

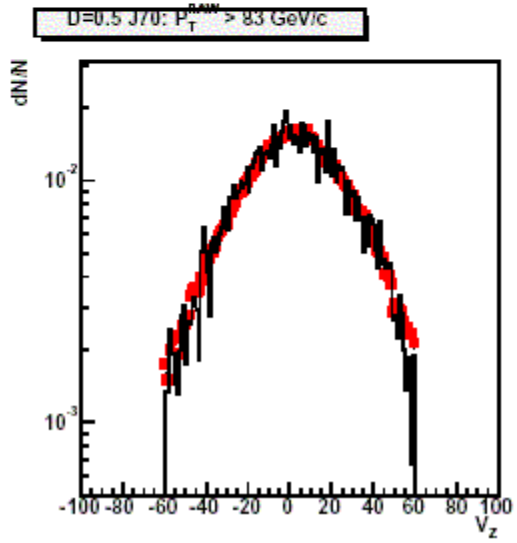

D=0.5 J70: P_T^{RAW} > 83 GeV/c
dN/N
Missing E_T significance [GeV$^{1/2}$]

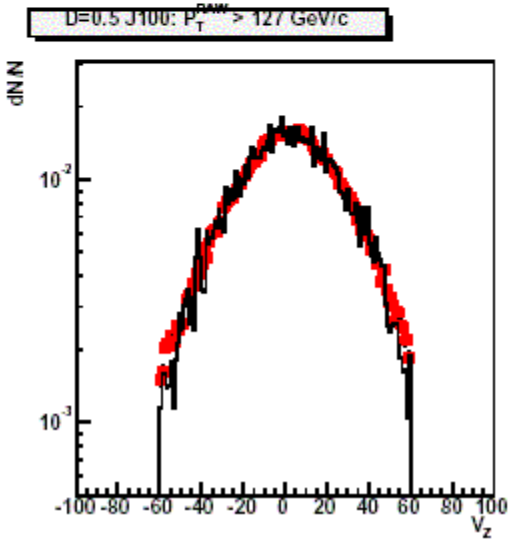

D=0.5 J100: P_T^{RAW} > 127 GeV/c
dN/N
Missing E_T significance [GeV$^{1/2}$]

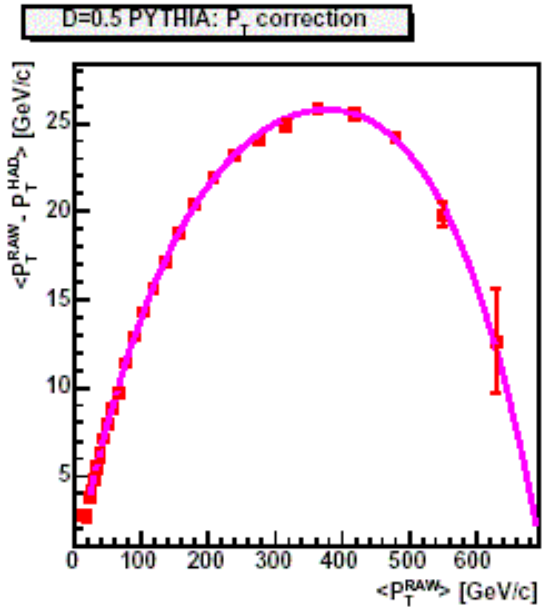

D=0.5 STW5: P_T^{RAW} > 23 GeV/c
dN/N
10^{-2}
10^{-3}
-100 -80 -60 -40 -20 0 20 40 60 80 100
V_z

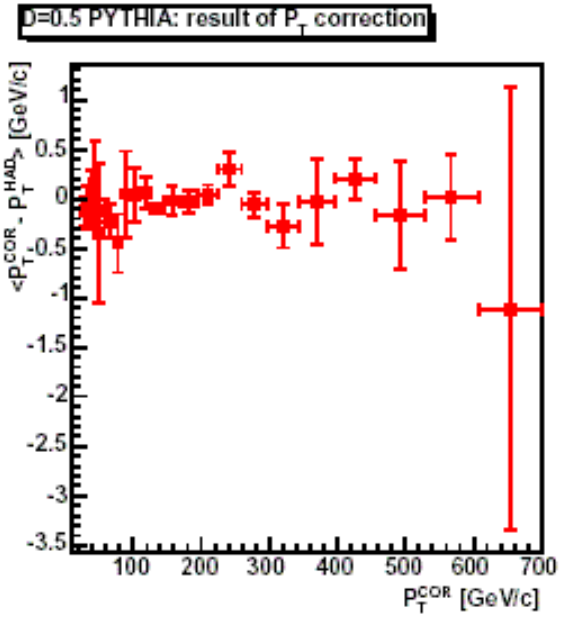

D=0.5 J20: P_T^{RAW} > 27 GeV/c
dN/N
10^{-2}
10^{-3}
-100 -80 -60 -40 -20 0 20 40 60 80 100
V_z

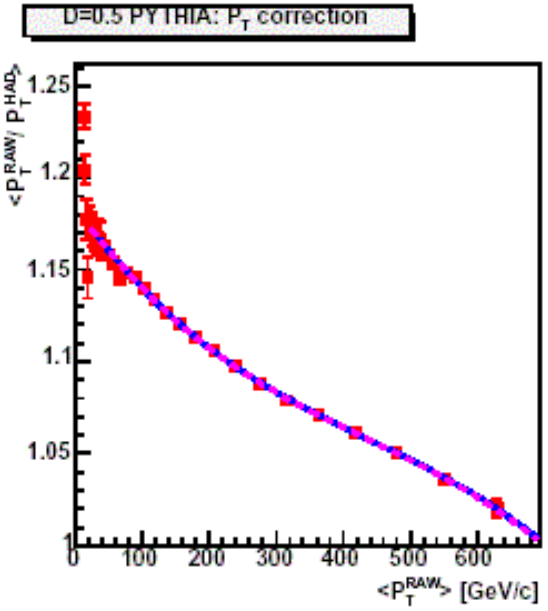

D=0.5 J50: P_T^{RAW} > 62 GeV/c
dN/N
10^{-2}
10^{-3}
-100 -80 -60 -40 -20 0 20 40 60 80 100
V_z

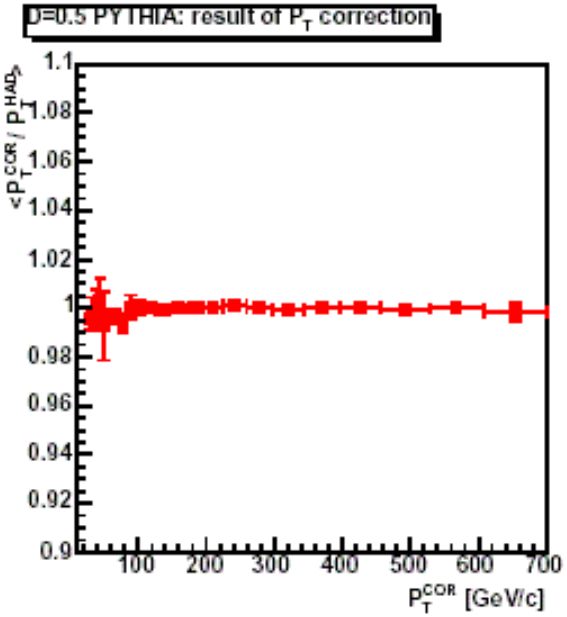

D=0.5 J70: P_T^{RAW} > 83 GeV/c
dN/N
10^{-2}
10^{-3}
-100 -80 -60 -40 -20 0 20 40 60 80 100
V_z

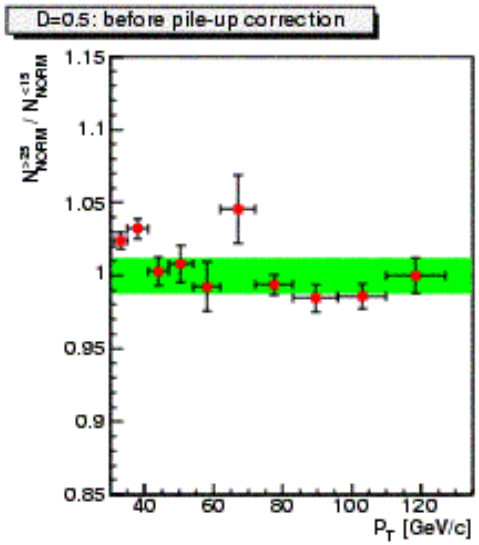

D=0.5 J100: P_T^{RAW} > 127 GeV/c
dN/N
10^{-2}
10^{-3}
-100 -80 -60 -40 -20 0 20 40 60 80 100
V_z

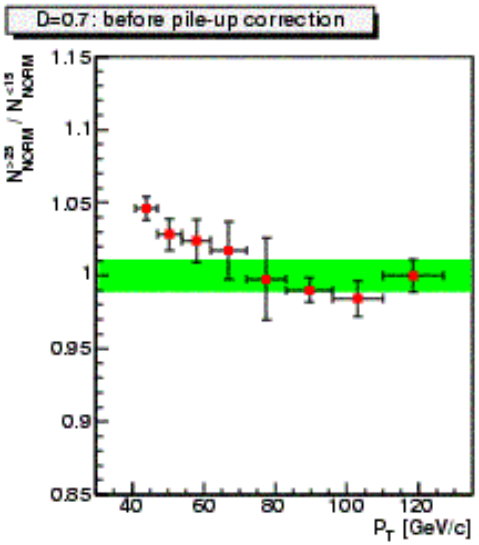

D=0.5 PYTHIA: P_T correction
$\langle P_T^{RAW} - P_T^{HAD} \rangle$ [GeV/c]
$\langle P_T^{RAW} \rangle$ [GeV/c]

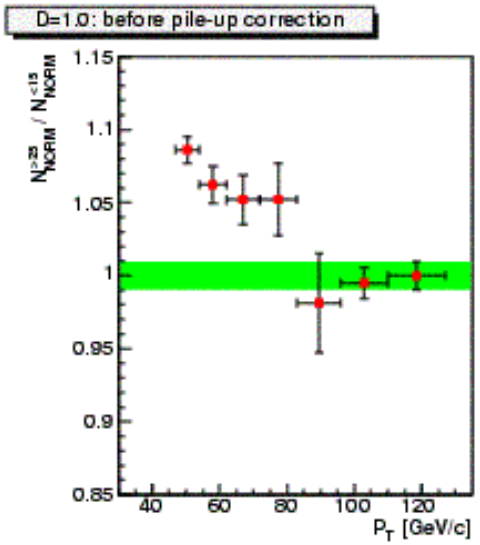

D=0.5 PYTHIA: result of P_T correction
$\langle P_T^{COR} - P_T^{HAD} \rangle$ [GeV/c]
P_T^{COR} [GeV/c]

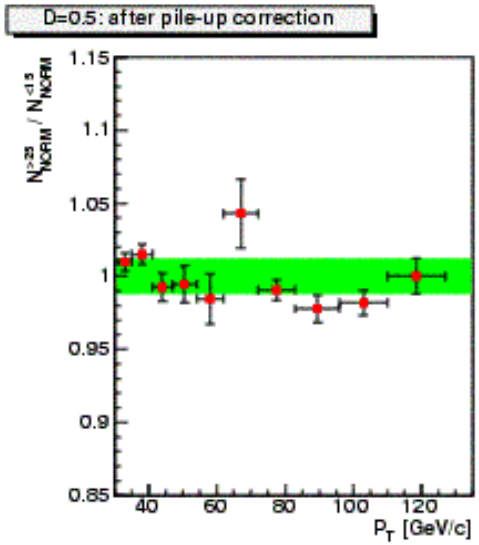

D=0.5 PYTHIA: P_T correction
$\langle P_T^{RAW} / P_T^{HAD} \rangle$
$\langle P_T^{RAW} \rangle$ [GeV/c]

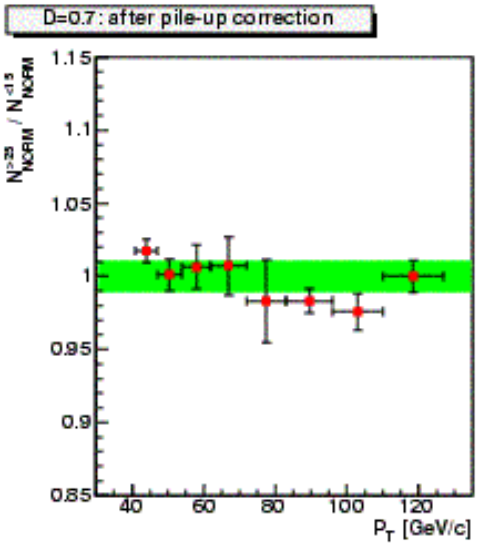

D=0.5 PYTHIA: result of P_T correction
$\langle P_T^{COR} / P_T^{HAD} \rangle$
P_T^{COR} [GeV/c]

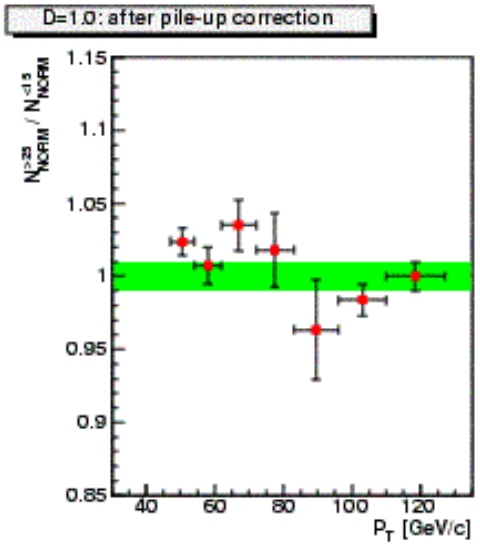

D=0.5: before pile-up correction
$N^{>25}_{NORM} / N^{<15}_{NORM}$
1.15
1.1
1.05
1
0.95
0.9
0.85
40
60
80
100
120
P_T [GeV/c]


D=0.7: before pile-up correction
$N^{>25}_{NORM} / N^{<15}_{NORM}$
1.15
1.1
1.05
1
0.95
0.9
0.85
40
60
80
100
120
P_T [GeV/c]


D=1.0: before pile-up correction
$N^{>25}_{NORM} / N^{<15}_{NORM}$
1.15
1.1
1.05
1
0.95
0.9
0.85
40
60
80
100
120
P_T [GeV/c]

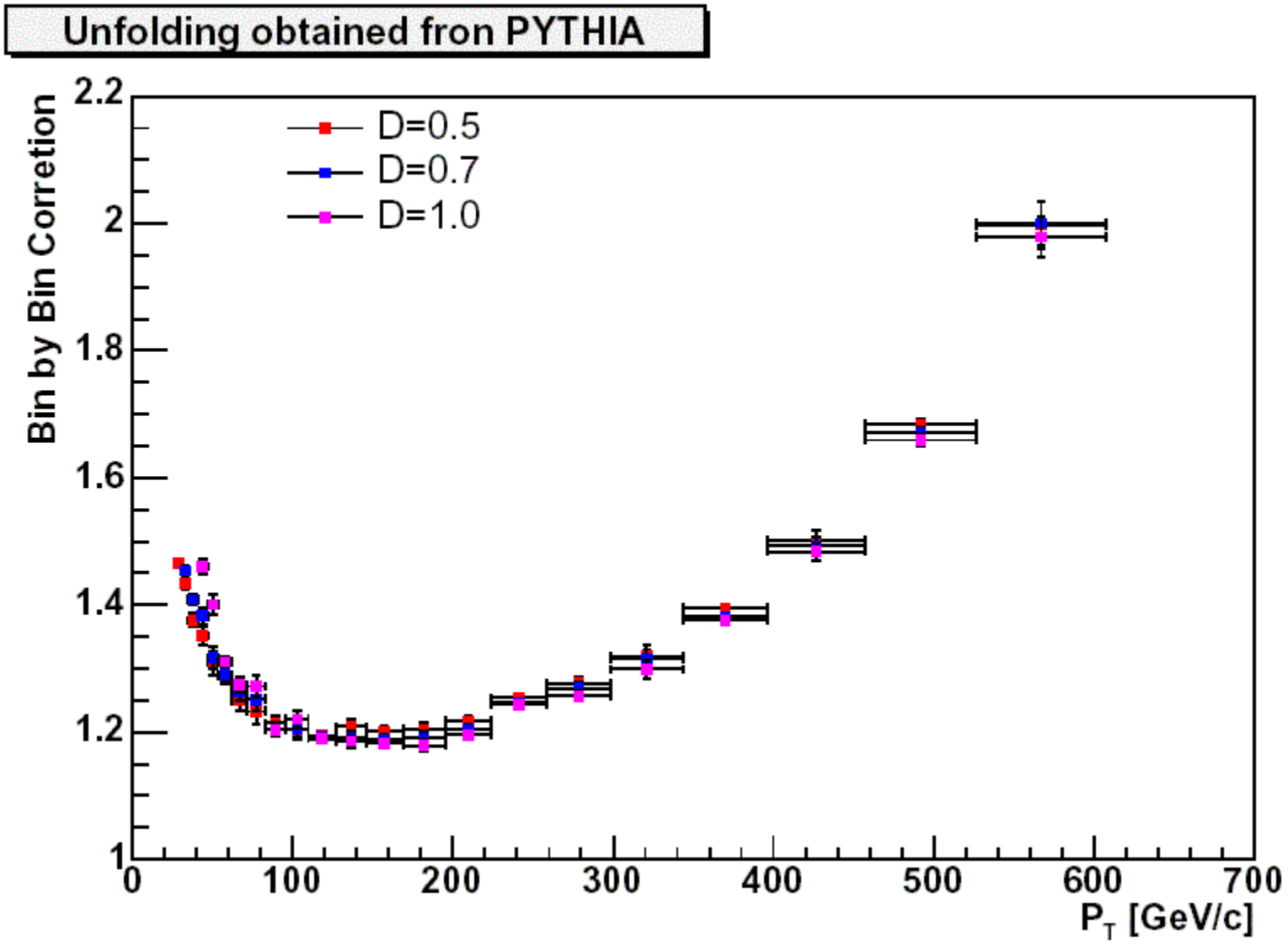

D=0.5: after pile-up correction
$N^{>25}_{NORM} / N^{<15}_{NORM}$
1.15
1.1
1.05
1
0.95
0.9
0.85
40
60
80
100
120
P_T [GeV/c]


D=0.7: after pile-up correction
$N^{>25}_{NORM} / N^{<15}_{NORM}$
1.15
1.1
1.05
1
0.95
0.9
0.85
40
60
80
100
120
P_T [GeV/c]


D=1.0: after pile-up correction
$N^{>25}_{NORM} / N^{<15}_{NORM}$
1.15
1.1
1.05
1
0.95
0.9
0.85
40
60
80
100
120
P_T [GeV/c]

Unfolding

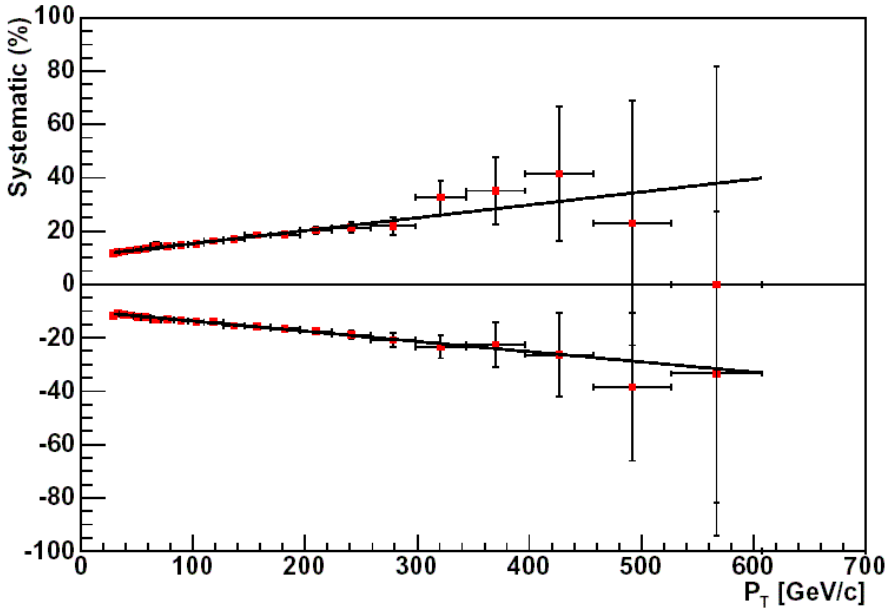
- A simple bin by bin correction is used
  - N hadron level / N calorimeter level (corrected P_T)
- Extract from PYTHIA


Unfolding obtained from PYTHIA
D=0.5
D=0.7
D=1.0
Bin by Bin Corretion
2.2
2
1.8
1.6
1.4
1.2
1
0
100
200
300
400
500
600
700
P_T [GeV/c]

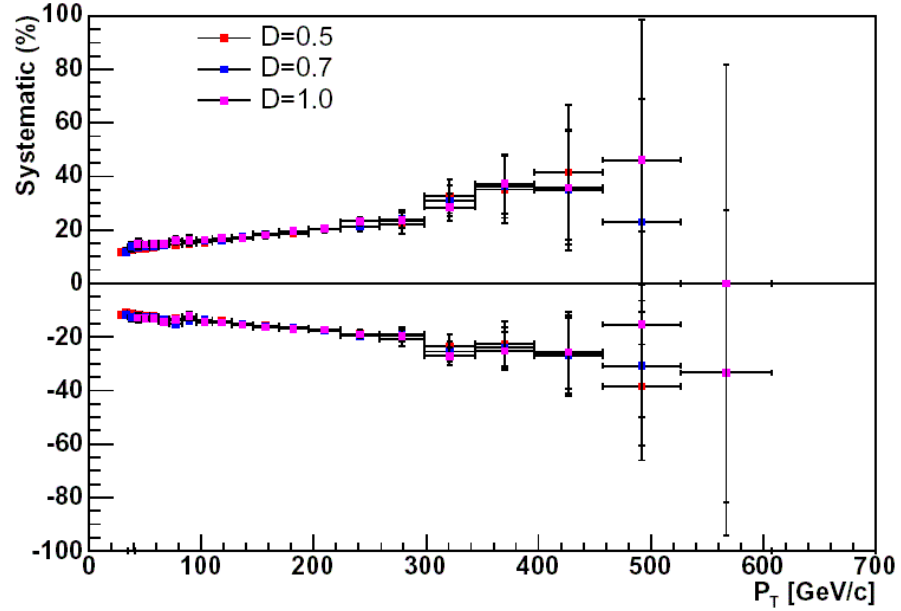
Systematics

- |Vz| cut
  - +/- 5 cm: effect lower than 1%
- Number of tracks associated to primary vertex
  - +/- 1 tracks: effect of the order of 0.1%
- Missing E_T significance cut
  - +/- 10% on missing E_T scale
    ⊗ +/- 3% on jet energy scale: effect lower than 0.3%
- MC statistics: lower than 2%
- +/- 3% on jet energy scale
- +/- 100% on pile-up correction
- +/- 3% on lower edge of each bin
- Unfolding: PYTHIA vs HERWIG

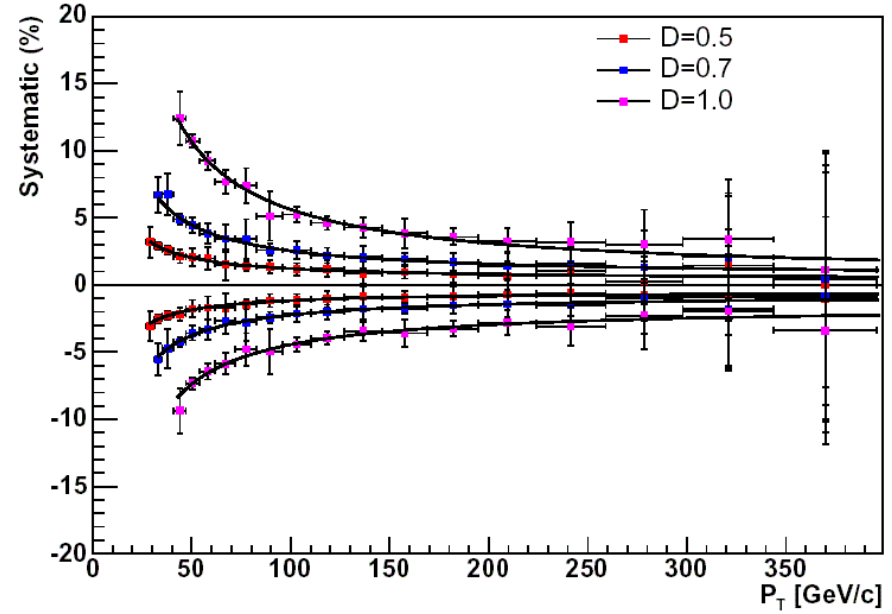
D=0.5: Jet Energy Scale changed of +/- 3%



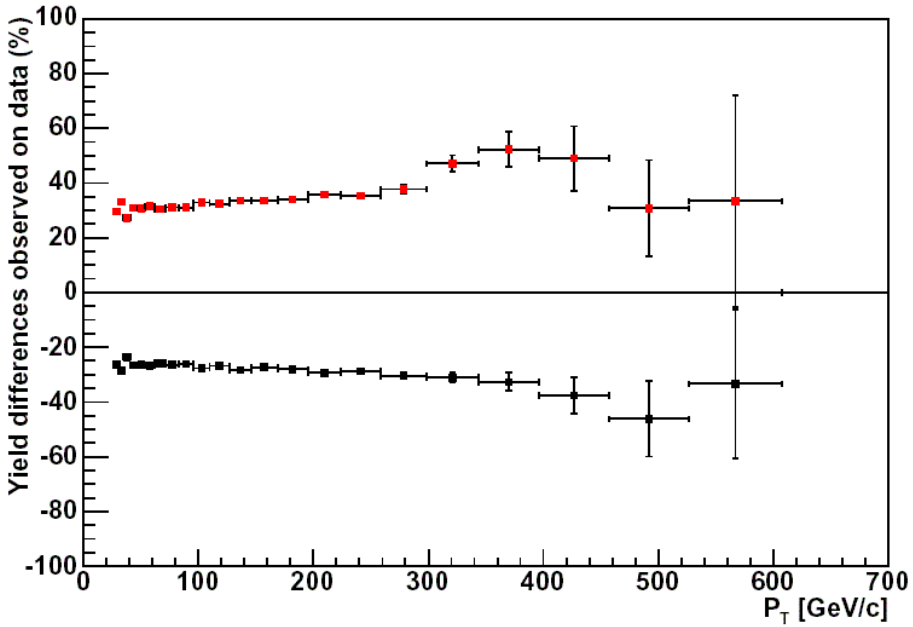
Jet Energy Scale changed of +/- 3%



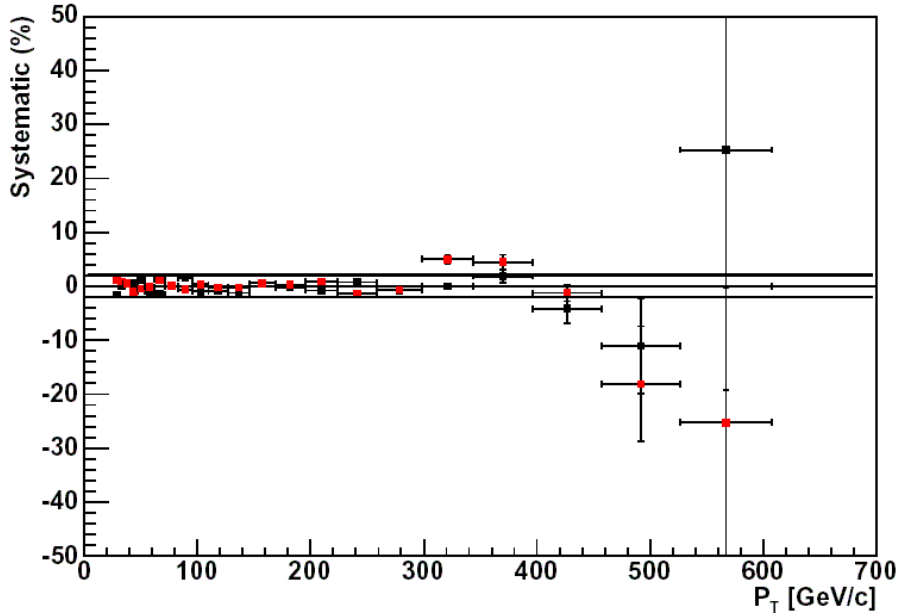
Pile-up energy correction changed of +/- 100%



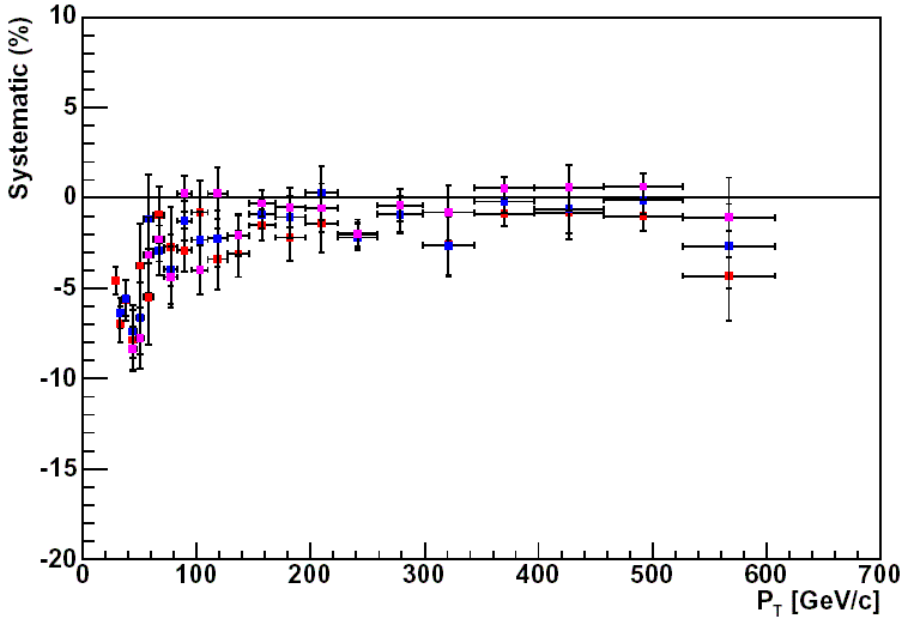
D=0.5: Lower edge of each bin moved of +/- 3%



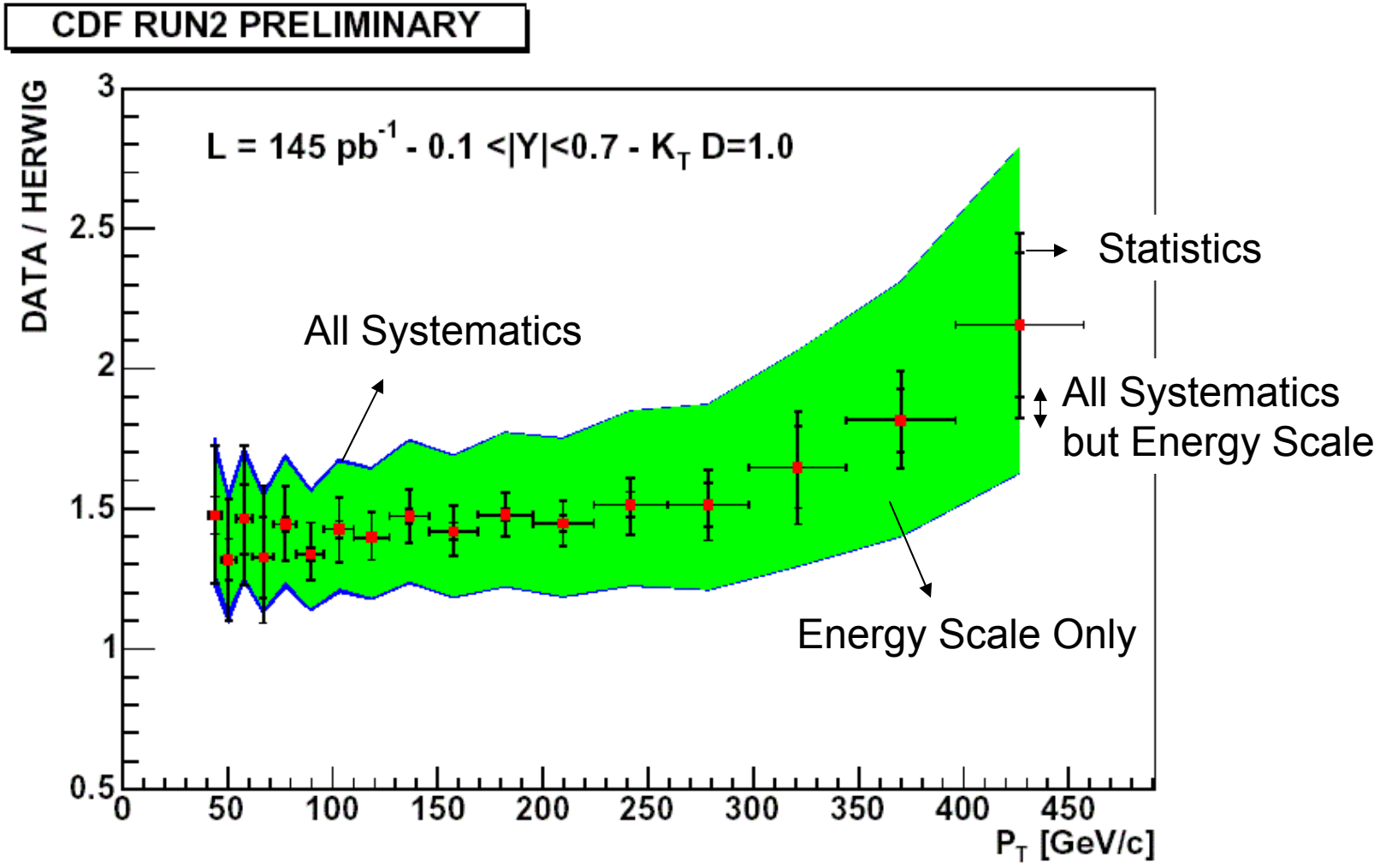
D=0.5: Lower edge of each bin moved of +/- 3%



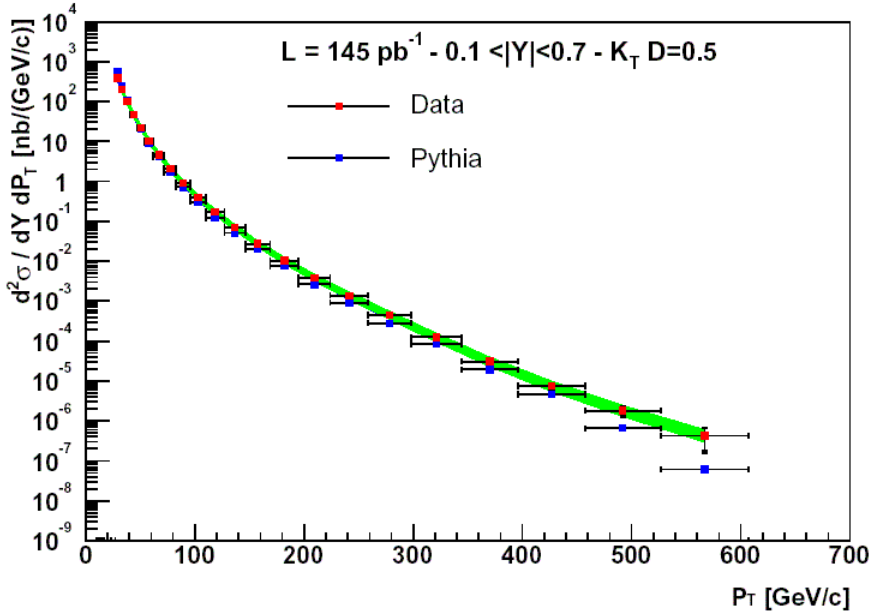
Unfolding systematic from Herwig and Pythia comparison



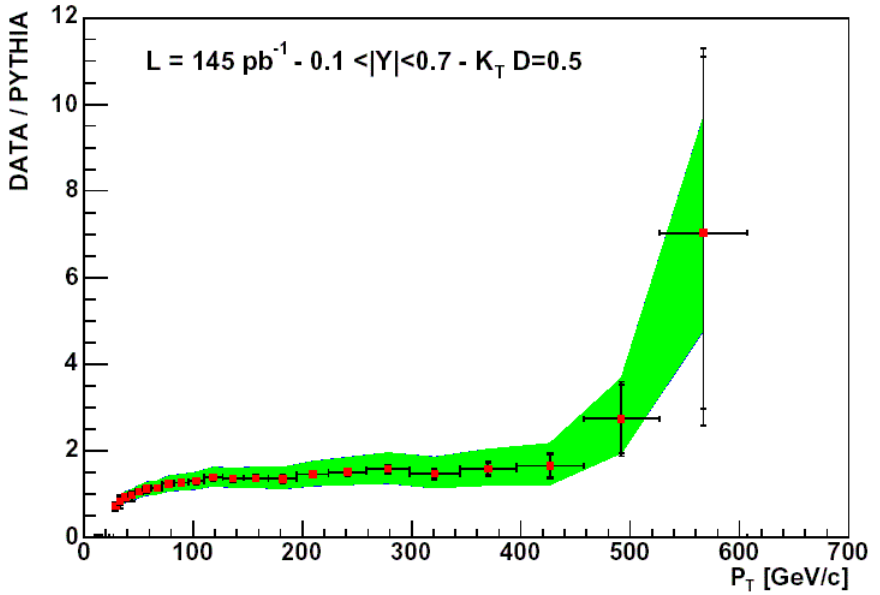
Results


CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=1.0
DATA / HERWIG
3
2.5
2
1.5
1
0.5
0
50
100
150
200
250
300
350
400
450
P_T [GeV/c]
Statistics
All Systematics
All Systematics but Energy Scale
Energy Scale Only

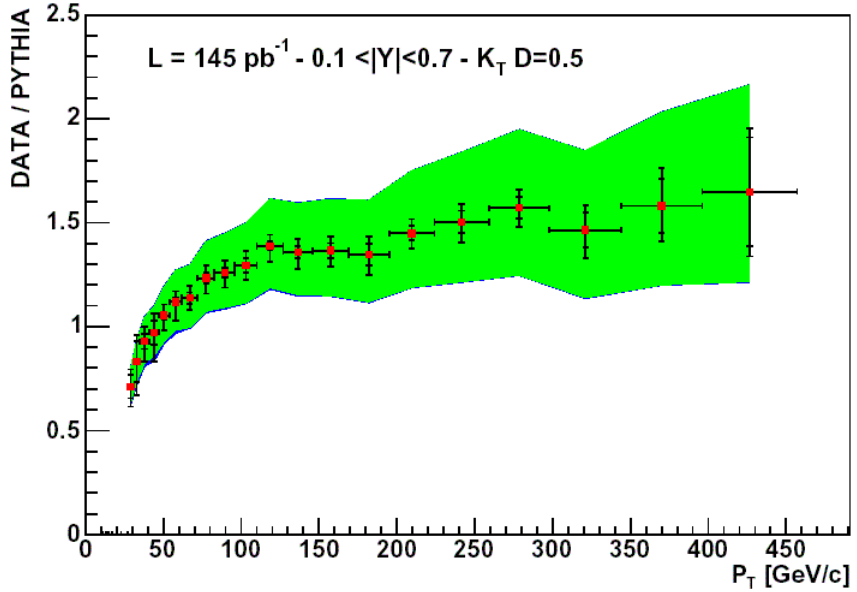
CDF RUN2 PRELIMINARY



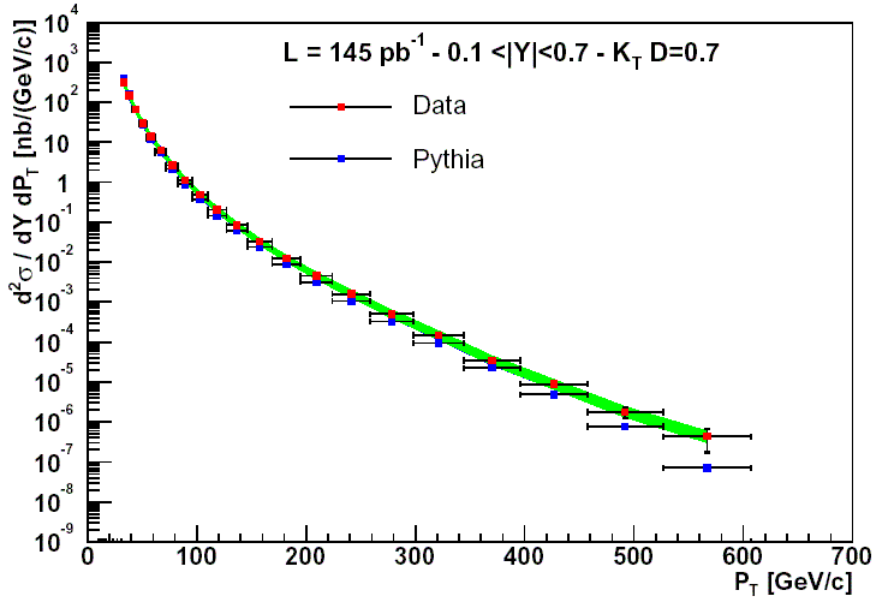
CDF RUN2 PRELIMINARY



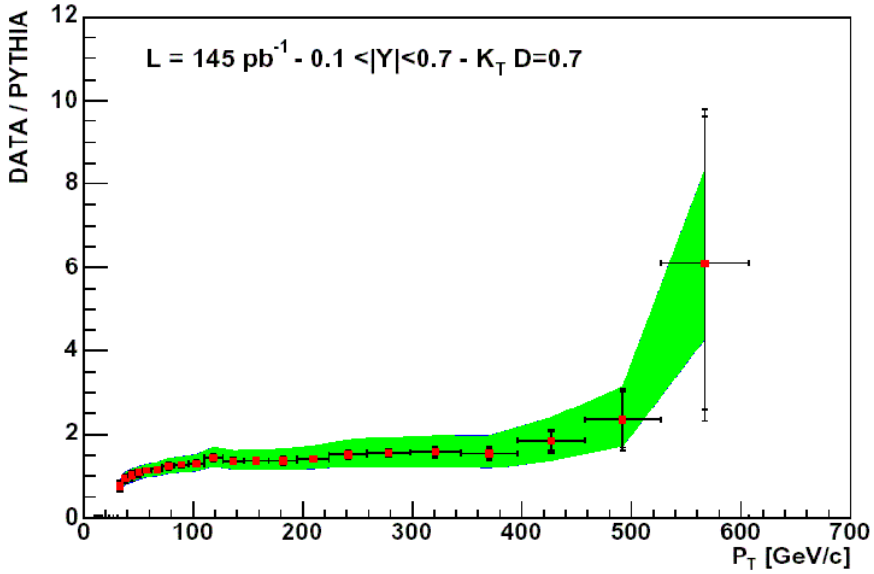
CDF RUN2 PRELIMINARY



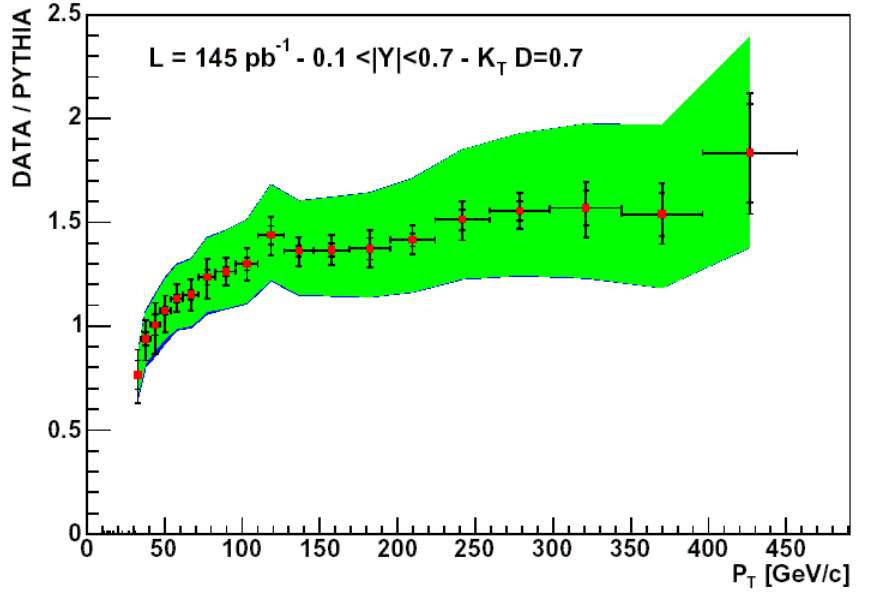
CDF RUN2 PRELIMINARY

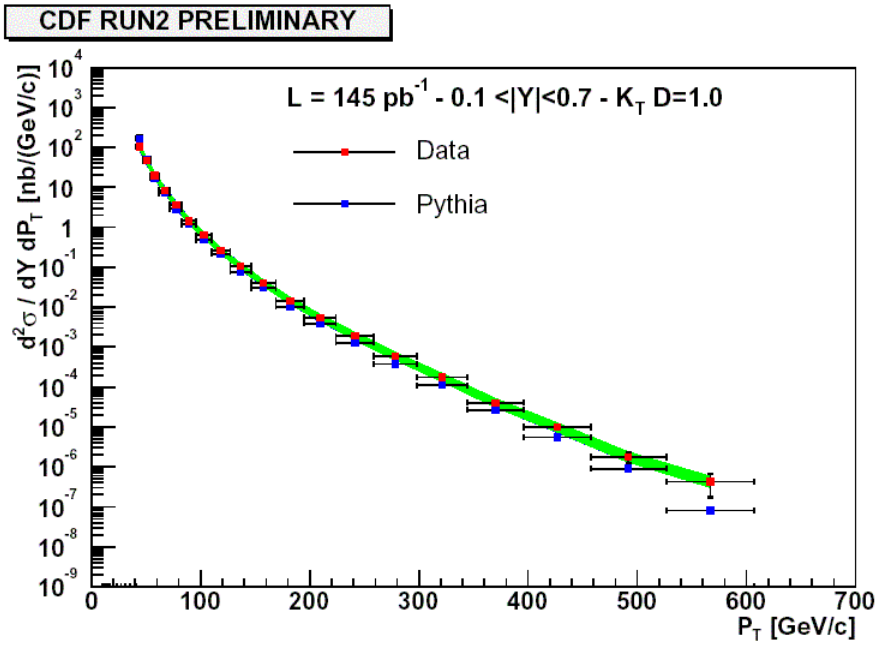


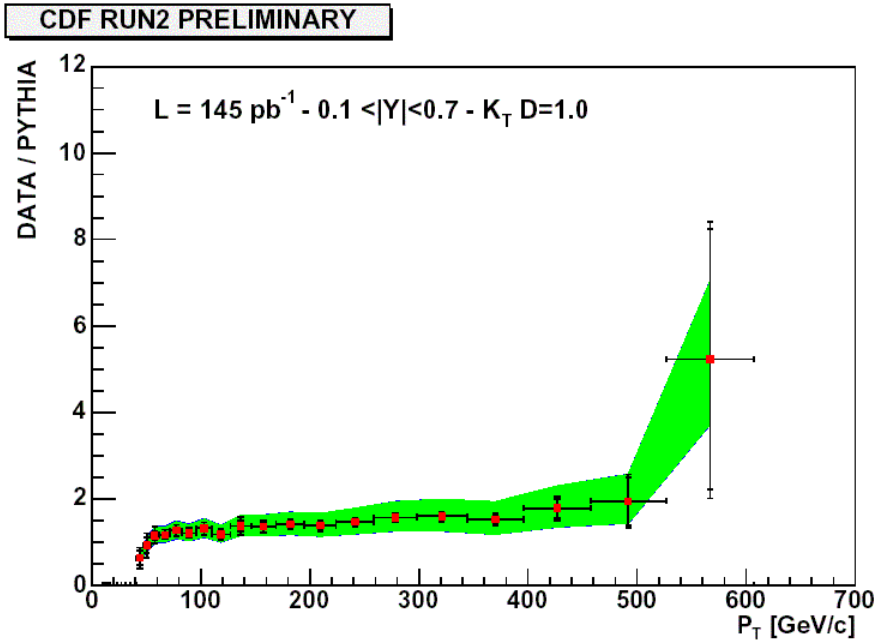
CDF RUN2 PRELIMINARY

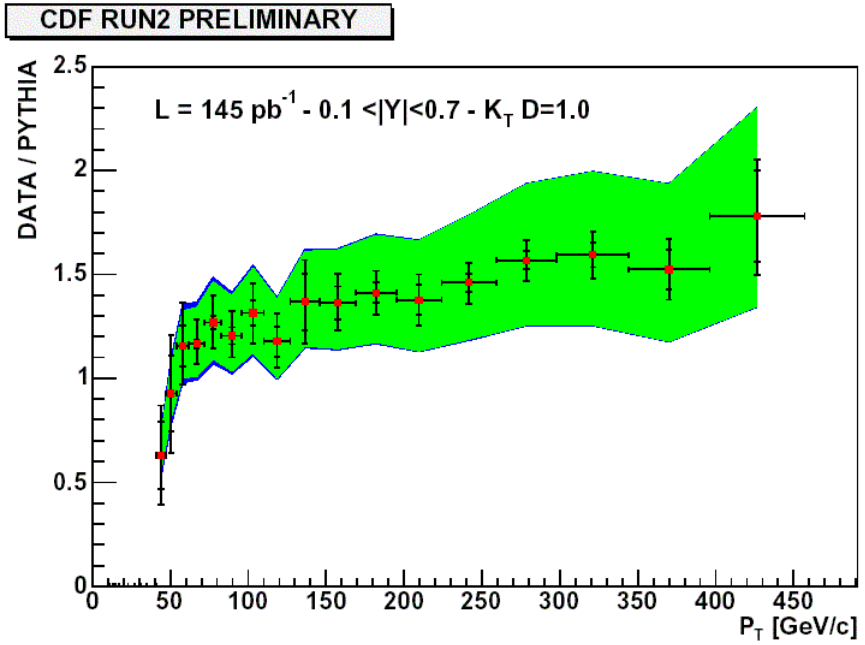


CDF RUN2 PRELIMINARY

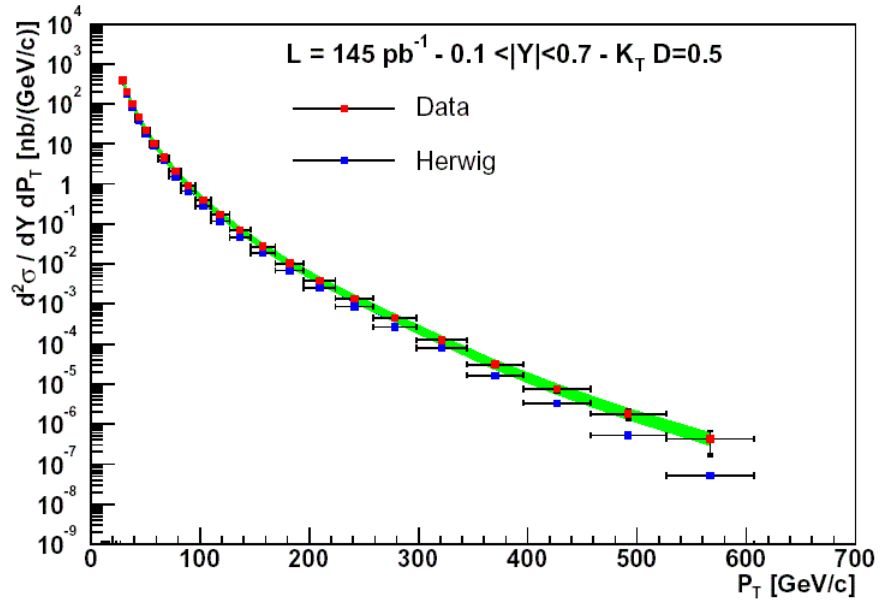



CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=1.0
Data
Pythia
$d^2\sigma$ / dY dP_T [nb/(GeV/c)]
P_T [GeV/c]

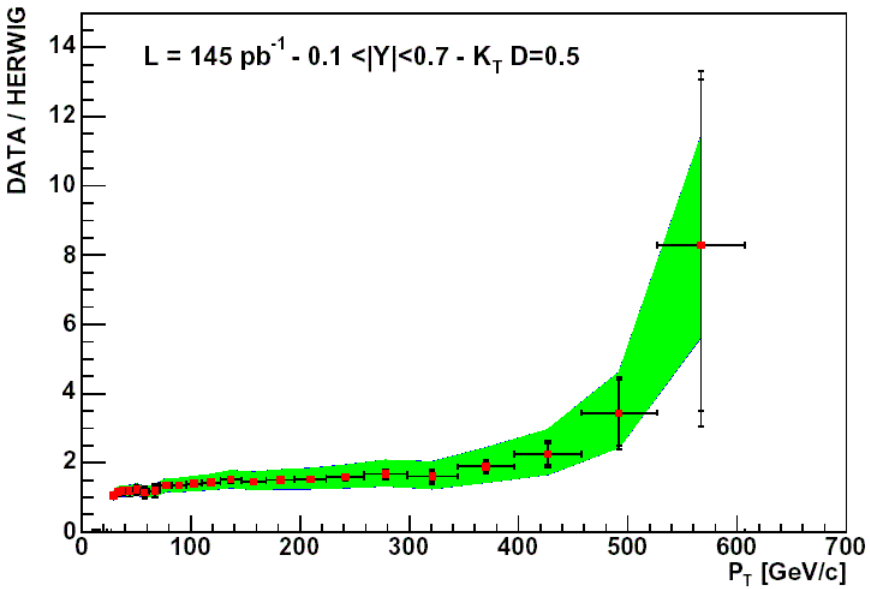

CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=1.0
DATA / PYTHIA
P_T [GeV/c]


CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=1.0
DATA / PYTHIA
P_T [GeV/c]

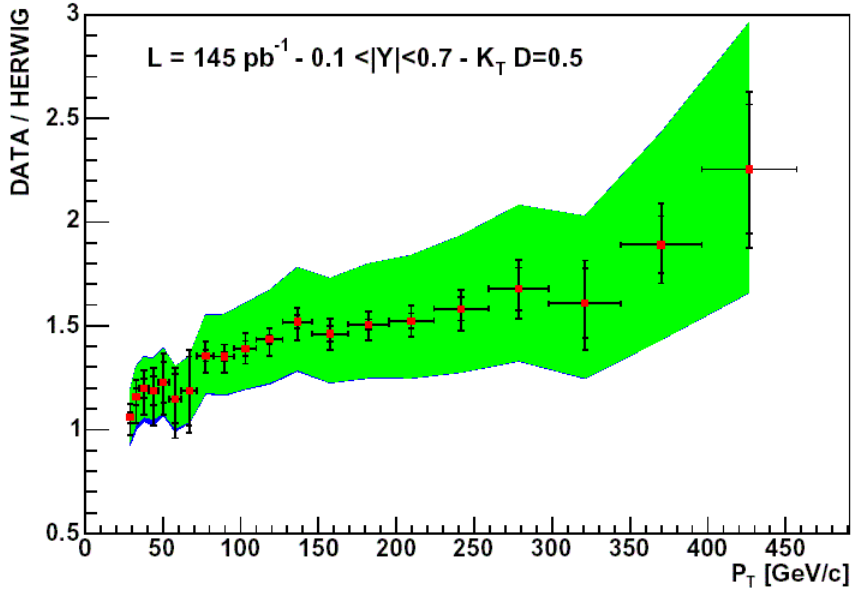
CDF RUN2 PRELIMINARY

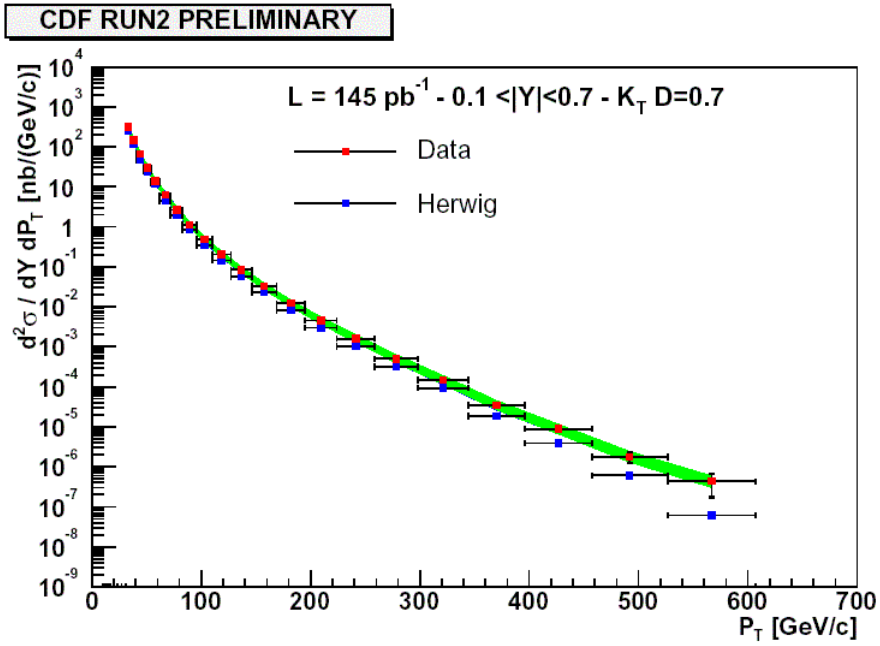


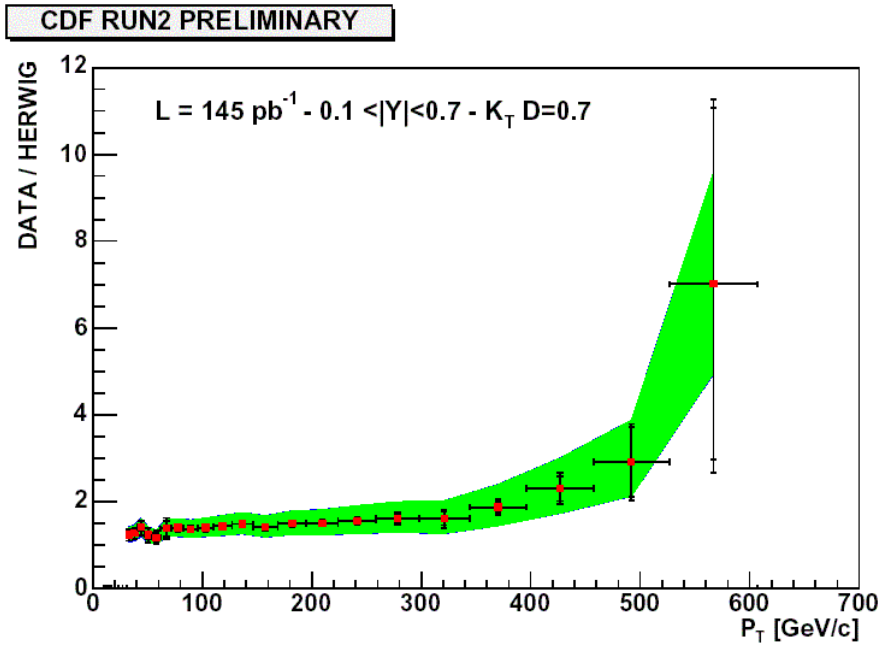
CDF RUN2 PRELIMINARY

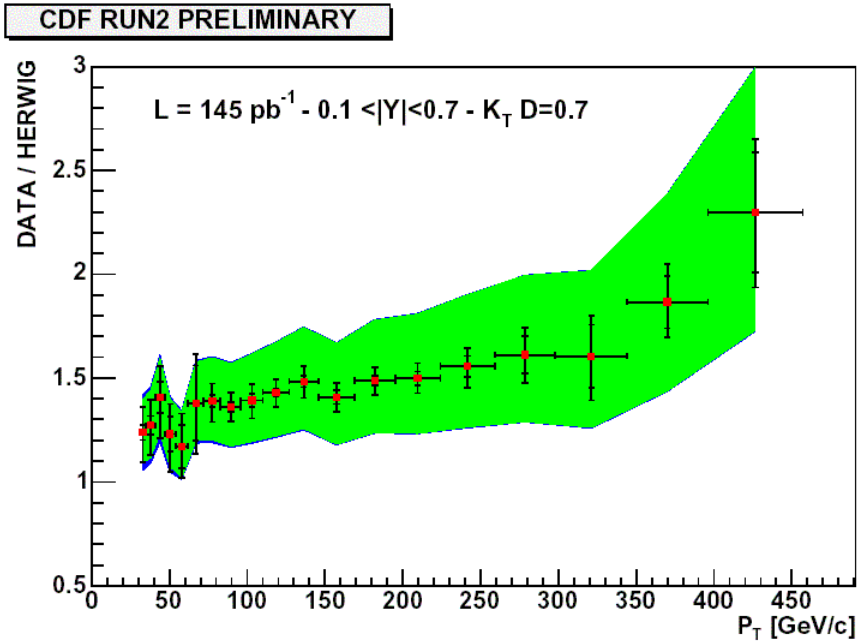


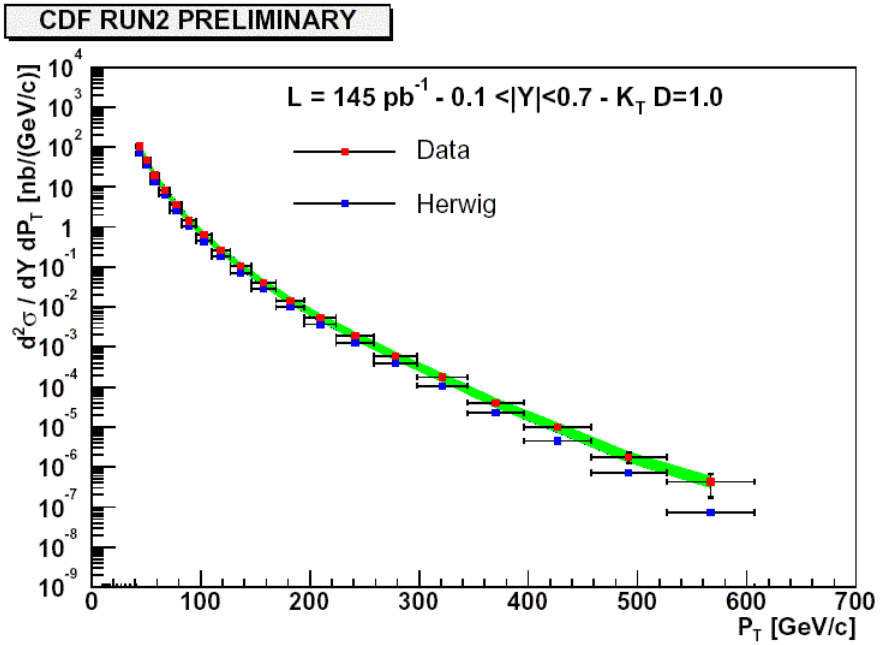
CDF RUN2 PRELIMINARY

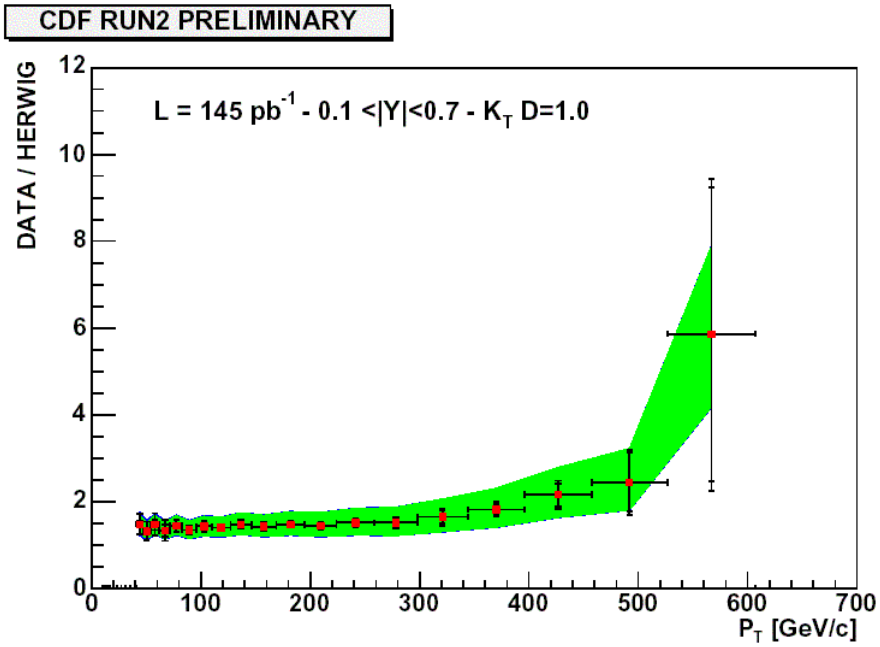


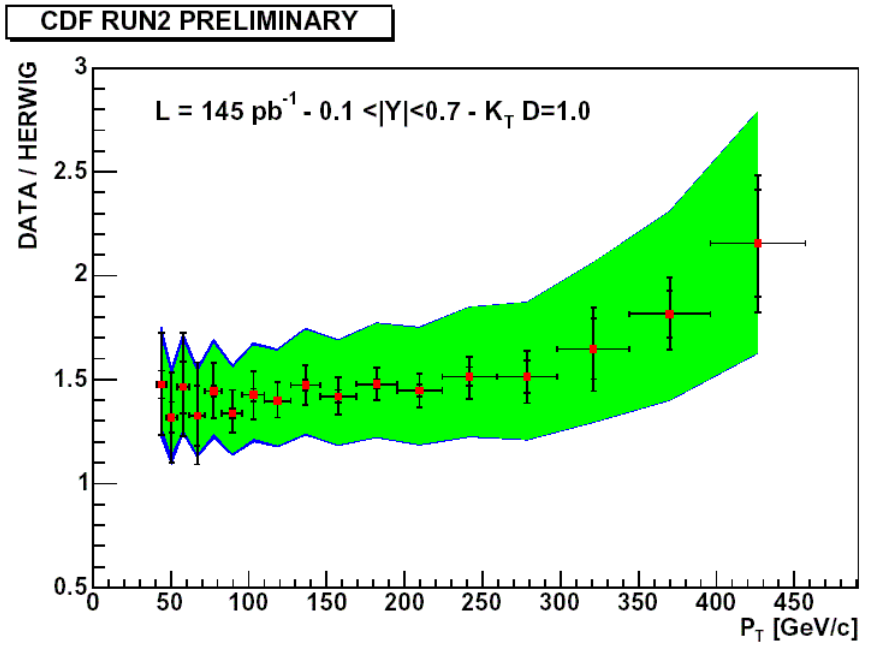

CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=0.7
Data
Herwig
$d^2\sigma$ / dY dP_T [nb/(GeV/c)]
P_T [GeV/c]


CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=0.7
DATA / HERWIG
P_T [GeV/c]


CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=0.7
DATA / HERWIG
P_T [GeV/c]


CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=1.0
Data
Herwig
$d^2\sigma$ / dY dP_T [nb/(GeV/c)]
P_T [GeV/c]


CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=1.0
DATA / HERWIG
P_T [GeV/c]


CDF RUN2 PRELIMINARY
L = 145 pb^{-1} - 0.1 <|Y|<0.7 - K_T D=1.0
DATA / HERWIG
P_T [GeV/c]

Comments

- Systematic from MC simulation of the calorimeters still missing
- ST5 has lower integrated luminosity
  - To be specified on plots?
  - Simply removed those points?
- In progress
  - NLO comparisons